Review of the Strait of Georgia Recreational Creel Survey, 1983-1999

K. English, G.F. Searing, and D. A. Nagtegaal

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9T 6N7

2002

Canadian Technical Report of Fisheries and Aquatic Sciences 2414

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1 - 456 in this series were issued as Technical reports of the Fisheries Research Board of Canada. Numbers 457 - 714 were issued as Department of the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon regional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

102-07372/

Canadian Technical Report of
Fisheries and Aquatic Sciences 2414

2002

REVIEW OF THE STRAIT OF GEORGIA RECREATIONAL CREEL SURVEY, 1983-1999

by

K. English[1], G. F. Searing,[1] and D. A. Nagtegaal

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9T 6N7

---

[1] LGL Limited, environmental research associates, 9768 Second St., Sidney, BC V8L 3Y8

©Her Majesty the Queen in Right of Canada, 2002, as represented
by the Minister of Fisheries and Oceans

Cat. No. Fs 97-6/2414E ISSN 0706-6457

Correct citation for this publication:

English, K., G.F. Searing, and D. A. Nagtegaal. 2002. Review of the Strait of Georgia recreational creel survey, 1983-1999. Can. Tech. Rep. Fish. Aquat. Sci. 2414: 81 p.

TABLE OF CONTENTS

LIST OF TABLES iv
LIST OF FIGURES v
LIST OF APPENDICES vii
ABSTRACT viii
RÉSUMÉ x
INTRODUCTION 1
Background 1
Survey Objectives 2
METHODS 3
Catch Per Effort and Activity Patterns 3
Aerial Survey Boat Counts 4
Assessment of the Effect of Survey Effort on Precision 5
RESULTS & DISCUSSION 6
Sampling Effort and Precision 6
Statistics Versus Logistics 7
Survey Changes 1983-1999 7
Program Review 2000 9
Activity Pattern Analysis 9
Variability in Aerial Survey Timing 11
Sub-Area Catch Per Effort Estimates 11
CONCLUSIONS 13
RECOMMENDATIONS 15
LITERATURE CITED 16
TABLES 17
FIGURES 27
APPENDICES 37

LIST OF TABLES

Table 1. Annual fishing effort and catch estimates for the Strait of Georgia recreational fishery, 1983-1999.....18

Table 2. Example of the effect of survey reductions on the precision and accuracy of the monthly chinook catch estimates for March, May and July 1987.....19

Table 3. Example of the effect of three options for survey reductions on the precision of the monthly and annual chinook catch estimates derived from the analysis of the 1987 creel survey data.....20

Table 4. Summary of the estimated survey costs, survey effort and precision of the annual chinook catch estimates relative to the observed results from the 1987 Georgia Strait Creel Survey.....21

Table 5. Means and standard errors for the percent of the total catch and effort occurring in each survey month or sequence of months (1987-1992).....22

Table 6. Sample size used to derive the daily fishing activity pattern for each survey stratum, 1998.....23

Table 7. Sample size used to derive the daily fishing activity pattern for each survey stratum, 1999.....24

Table 8. Recommended times for conducting aerial survey boat counts in each of the Georgia Strait Creel Survey regions by month and day type based on analysis of the 1998 activity pattern data.....25

Table 9. Three levels of CPE groupings used to estimate catch for each sub-area.....26

LIST OF FIGURES

Figure 1. Annual fishing effort and catch estimates for chinook and coho salmon for the Strait of Georgia recreational fishery 1983-1999.....28

Figure 2. Annual fishing effort and catch estimates for pink and sockeye salmon for the Strait of Georgia recreational fishery 1983-1999.....28

Figure 3. Annual fishing effort and catch estimates for rockfish and lingcod for the Strait of Georgia recreational fishery 1983-1999.....28

Figure 4. Monthly distribution of interviews and survey shifts for the Georgia Strait creel survey in 1988.....29

Figure 5. Monthly distribution of fishing effort and aerial surveys for the Georgia Strait creel survey in 1988.....29

Figure 6. Annual interview survey effort expressed in term of the number of interview shifts and months surveyed each year from 1986-1999.....30

Figure 7. Annual aerial survey effort expressed in term of the number of aerial surveys of the entire fishing area and months surveyed each year from 1986-1999.....30

Figure 8. Surveyor shifts and angler interviews during the April-September period when creel surveys were conducted each year from 1986-1999.....31

Figure 9. Angler effort and the number of aerial surveys during the April-September period when creel surveys were conducted each year from 1986-1999.....31

Figure 10. Annual aerial survey effort and the precision of the effort estimate expressed using the coefficient of variation (CV), 1986-1999.....32

Figure 11. Annual interview effort and the precision of the chinook catch estimate expressed using the coefficient of variation (CV), 1986-1999.....32

Figure 12. Annual interview effort and the precision of the coho catch estimate expressed using the coefficient of variation (CV), 1986-1999.....32

Figure 13. Sport fishing activity patterns for Victoria and Saanich Inlet, May-August, 1999....33

Figure 14. Comparison of the spatial resolution for Level 2 and Level 3 sub-area groups, where CPE is estimated by combining all the data from sub-areas with the same colour to estimate catch for the component sub-areas.....34

LIST OF FIGURES (CONT.)

Figure 15. Comparison of the catch estimates for the 1998 Strait of Georgia recreational fishery derived using the "old" and "new" estimation procedures.....35

Figure 16. Comparison of the catch estimates for the 1999 Strait of Georgia recreational fishery derived using the "old" and "new" estimation procedures.....35

Figure 17. Comparison of the coefficients of variation for the1998 Strait of Georgia recreational fishery catch estimates derived using the "old" and "new" estimation procedures....36

Figure 18. Comparison of the coefficients of variation for the1999 Strait of Georgia recreational fishery catch estimates derived using the "old" and "new" estimation procedures....36

LIST OF APPENDICES

Appendix A. Strait of Georgia Creel Survey Study Area.....38

Appendix B. Methods and Equations.....39

Appendix C. Sport Fishing Activity Patterns.....53

Appendix D. Monthly Catch and Effort Statistics for 1983-1999.....61

Appendix E. Aerial Survey Timing Options.....64

Appendix F. Comparison of Effort Estimates by Month and Statistical Area for 1998 derived using the "old" and "new" Analyses Methods.....67

Appendix G. Comparison of Catch Estimates by Month and Statistical Area for 1998 derived using the "old" and "new" Analyses Methods.....70

Appendix H. Comparison of Catch Estimates by Month and Statistical Area for 1999 derived using the "old" and "new" Analyses Methods.....76

ABSTRACT

English, K., G.F. Searing, and D. A. Nagtegaal. 2002. Review of the Strait of Georgia recreational creel survey, 1983-1999. Can. Tech. Rep. Fish. Aquat. Sci. 2414: 81 p.

The Strait of Georgia Creel Survey monitors recreational fishing activity throughout the Strait of Georgia and the Canadian portion of Juan de Fuca Strait (roughly 8,300 sq. km). The fishery is open year round and is readily accessible to over 300,000 anglers who catch a wide variety of salmon and groundfish species. The area's large number of access points and variable patterns of fishing activity and catch rates provide many challenges for a catch monitoring program. The creel program was initially designed to provide reliable monthly estimates of fishing effort and the catch of chinook and coho for the entire fishery. However, monthly catch and effort statistics have been computed for 9 statistical and 62 sub-areas. From 1983-1992, the creel survey covered the entire year, but in recent years, the surveys have been limited to the peak fishing months (April-September).

The creel survey has undergone numerous reviews over the years and many analyses have been conducted to assess the effect of reducing sampling effort on the precision of the catch estimates. Analyses conducted in 1988 clearly showed that relatively high levels of precision (95% confidence intervals of less than $\pm$10% of the chinook catch estimate) could be achieved with substantial reductions in survey effort in high effort years. However, the practical logistics associated with the coverage of the survey and the need to provide full-time jobs to obtain quality surveyors were the major factors determining the minimum acceptable level of angler interview survey effort. Substantial reductions in survey costs have been achieved by streamlining all survey components (i.e. hiring, training, data entry, analysis, supervision), reducing the number of aerial surveys per month and the number months covered by the survey. The major determinant of precision over the years has been the magnitude of the fishing effort which in turn affects the number of interviews and data used to define the activity patterns. The timing of the aerial survey has also had a significant impact on precision in specific instances where some boat counts were conducted at times when the activity pattern indicates that very few boats were fishing. The precision of the effort estimate, expressed as a 95% confidence interval, has been less than $\pm$6% in every year, except 1992 and 1995. The poor precision in these two years was due to aerial survey timing and large variation in the boat counts for a specific month-statistical area stratum. The precision of the annual chinook catch estimate was consistently less than $\pm$6.6% prior to 1990 but subsequent estimates have been less precise and ranged between $\pm$6.6% and $\pm$17.6%. The primary factors that determined the precision of the chinook catch estimates after 1990 were the number of interviews and size of the chinook catch. The precision of the annual coho catch estimates were similar to those for chinook prior to 1998. The precision of the coho catch has declined substantially with the size of the total catch. In 1998 and 1999, when the annual coho catch estimates was less than 2,000 fish, the 95% confidence intervals were 27% and 35%, respectively.

The changes in the Strait of Georgia sport fishery and creel survey implementation in recent year precipitated a review of the study design and data analysis systems in 2000. The review found that declines in fishing activity were having a significant impact on the estimates of the daily fishing activity pattern for several areas. Also, changes to the data analyses procedures

were required to accommodate the increased variability in aerial survey timing resulting from the shift from charter aircraft to Coast Guard aircraft. Additional analyses were conducted to assess the benefits of using sub-area specific catch per effort (CPE) rather than group landing site CPE to compute the catch estimates. Comparisons of catch estimates for 1998 and 1999 revealed substantial differences in the estimates derived from the two analysis approaches for some species. The "old" approach could produce inaccurate catch estimates for specific fishing areas, when the link between the fishing location and the landing site is not examined and updated each month. The "new" analytical approach described in this report is much more robust to changes in fishing patterns and the distribution of survey effort than "old" data analysis procedures.

RÉSUMÉ

English, K., G.F. Searing, and D. A. Nagtegaal. 2002. Review of the Strait of Georgia recreational creel survey, 1983-1999. Can. Tech. Rep. Fish. Aquat. Sci. 2414: 81p.

L'enquête par interrogation des pêcheurs dans le détroit de Georgia permet de surveiller les activités de pêche sportive dans l'ensemble du détroit et dans la portion canadienne du détroit de Juan de Fuca (environ 8 300 km^2). La pêche est ouverte toute l'année et attire 300 000 pêcheurs qui capturent une variété de saumons et de poissons de fond. Le grand nombre de points d'accès et la variabilité des activités de pêche et des taux de captures rendent le programme de surveillance des prises très difficile. Celui-ci a d'abord été conçu pour obtenir des estimations mensuelles fiables sur l'effort de pêche ainsi que sur les prises de saumons quinnats et cohos sur l'ensemble du secteur de pêche. Les statistiques pour les prises mensuelles et l'effort de pêche ont été calculées pour 9 secteurs statistiques et 62 sous-secteurs. De 1983 à 1992, l'enquête couvrait l'année entière mais au cours des dernières années, l'enquête s'est limitée aux mois de pêche les plus intenses (d'avril à septembre).

D'année en année, l'enquête par interrogation des pêcheurs a fait l'objet d'un grand nombre d'examens et de nombreuses analyses ont été effectuées pour évaluer l'effet de diminuer les efforts d'échantillonnage sur la précision des estimations concernant les prises. Les analyses effectuées en 1988 montrent clairement qu'un même niveau de précision élevé (intervalle de confiance de 95 % inférieur à $\pm$10 % pour la précision des estimations des prises de saumons quinnats) pourrait être atteint après avoir réduit de manière substantielle l'étendue de l'enquête lors des années où l'effort de pêche est important. La logistique associée à la couverture de l'enquête et le besoin d'offrir des postes à plein temps pour avoir sous la main des enquêteurs compétents ont cependant étaient des facteurs qui ont jusqu'alors déterminé le nombre minimal acceptable d'interviews de pêcheurs. D'importantes réductions du coût des enquêtes ont été réalisées en en rationalisant tous les aspects (c.-à-d. embauche, formation, entrée des données, analyse, supervision) ainsi qu'en réduisant la fréquence mensuelle des relevés aériens et la période couverte par les enquêtes. Le déterminant majeur de la précision au cours des ans s'est révélé être l'amplitude de l'effort de pêche qui définit le nombre d'interviews et les données utilisées pour définir les modes d'activités. La date des relevés aériens a aussi eu un impact important sur la précision lorsque le décompte des bateaux était effectué pendant des périodes où l'activité était faible. La précision de l'estimation de l'effort de pêche, exprimée comme la largeur de l'intervalle de confiance à 95 %, est restée inférieure à $\pm$ 6 % au cours des dernières années, sauf en 1992 et en 1995. La faible précision obtenue pour ces deux années est due au choix de la date du relevé aérien et à la grande variabilité des décomptes de bateaux pour une tranche statistique mensuelle donnée. L'intervalle de confiance pour les estimations des prises annuelles de saumons quinnats est resté inférieur à $\pm$6,6 % avant 1990 mais certaines estimations postérieures ont été moins précises et leur intervalle de confiance variait entre $\pm$ 6,6 % et $\pm$ 17,6 %. Les principaux facteurs qui ont déterminé la précision des estimations des prises de

saumons quinnats après 1990 ont été le nombre d'interviews auprès des pêcheurs et le nombre de saumons quinnats capturés. La précision des estimations annuelles des prises de saumons cohos a été du même ordre de grandeur que celle obtenue pour le saumon quinnat avant 1998. La précision des estimations pour les prises de saumons cohos a diminué de façon importante avec le nombre total des prises. En 1998 et 1999, lorsque l'on estimait des prises annuelles pour le saumon coho inférieures à 2 000 poissons, les intervalles de confiance à 95 % étaient respectivement de 27 % et 35 %.

Les changements intervenus dans la pêche récréative et la mise en œuvre des enquêtes par interrogation des pêcheurs dans le détroit de Georgia au cours des dernières années ont motivé en 2000 l'examen de la méthodologie et des systèmes d'analyse des données utilisés pour l'enquête. Cet examen a montré que le déclin des activités de pêche avait un impact important sur les estimations des activités halieutiques quotidiennes pour plusieurs secteurs. Des changements dans les procédures d'analyse des données ont également été nécessaires pour tenir compte de la variabilité accrue du choix de la date pour les relevés aériens, variabilité due à l'abandon des avions nolisés pour les avions de la Garde côtière. Des analyses supplémentaires ont été effectuées pour évaluer les bénéfices découlant de l'utilisation du taux de réussite des pêcheurs par secteur plutôt que par site de débarquement pour estimer le nombre de prises. La comparaison des nombres estimés de prises pour 1998 et 1999 montre que les deux types d'estimation diffèrent largement pour certaines espèces. La « vieille » approche peut produire être imprécise pour certains secteur de pêche si l'on n'examine pas chaque mois le lien entre le site de pêche et le site de débarquement. La « nouvelle » approche analytique décrite dans ce rapport résiste mieux que la « vieille » aux fluctuations de l'activité halieutique et à la distribution de l'effort d'échantillonnage lors de l'enquête.

INTRODUCTION

BACKGROUND

The Strait of Georgia sport fishery is the largest recreational fishery on Canada's Pacific coast. Annual fishing effort has ranged from over 660,000 boat trips in 1988 when the coho catch exceeded 1 million to a low of 174,000 in 1998 when the coho fishery was closed and chinook catch rates were low (Table 1 and Figure 1).

The recreational fishery is active throughout the year but over 85% of the effort occurs in the summer months of May to September. The most sought after species in the Strait of Georgia recreational fishery has been chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon, but in recent years with increased conservation concerns (eg: coho non-retention implemented in 1998), fisheries directed at pink (*O. gorbuscha*) and sockeye salmon (*O. nerka*), rockfish (*Sebastes)*, lingcod *(Ophiodon elongatus)*, and halibut (*Hippoglossus stenolepis*) have expanded in certain areas (Figures 2,3).

Over the past three decades, the recreational fishery in the Strait of Georgia has undergone dramatic changes. Prior to 1960, the numbers of chinook and coho taken by the commercial troll fleet in the Strait of Georgia was almost double that taken by sport anglers. During the 1980's this trend was reversed, with the sport fishery taking more than triple the commercial harvest of chinook and coho. The recreational fishery is now the primary harvester of chinook and coho in the Strait of Georgia. Effort in the recreational fishery has fluctuated from about 200,000 boat trips in 1960 to peaks of 769,000 in 1980 and 600,000 in 1988 to an all time low of 162,000 boat trips in 1998. The 1999 fishery showed a minor 1% increase in effort to 164,000 boat trips. The chinook catch climbed through the 1960's with a peak in the mid 1970's of over 400,000 pieces and a second peak of 370,000 pieces in 1984. A steady decline has occurred since, to a low of 20,000 pieces in 1998. Although annual coho catches have varied widely, an increase from about 200,000 pieces in 1960 to over one million pieces in 1988 was recorded. A gradual decline from 1988 levels to 100,000 pieces in 1997 has followed the general decline of stocks. Since 1998, non-retention of coho was implemented in the Strait of Georgia with only limited selective (hatchery only) fisheries in some terminal areas (Hardie et al. 1999).

From 1956 to 1976, estimates of catch and effort in the sport fishery published by the Department of Fisheries and Oceans (DFO) were based on subjective assessments completed by Fishery Officers and on small-scale creel surveys. The general lack of statistical rigor and consistency associated with these methods of catch estimation as well as the rapid growth of the recreational fishery led to the initiation of the Strait of Georgia Creel Survey Pilot Program in 1980 (DPA 1981). Since then a comprehensive recreational creel survey has been conducted each year, although considerable reductions in the level of effort expended for aerial boat counts and angler interview information has occurred in recent years. Survey details such as sampling locations and times have been regularly updated to reflect changes in the fishery, but the basic design of the survey has remained similar to the pilot project conducted in 1980 (Figures 6-9).

The creel survey study area (Appendix A) comprises over 5,900 km^2 of water surface area and has in excess of 2,400 km of shoreline. From its southern end near Victoria, the area extends about 290 km northwest to Campbell River and at its greatest width is about 32 km wide. Two major population centres, Vancouver and Victoria, and many smaller centres such as Nanaimo and Campbell River are located within the study area. Over 500 boat launch ramps, marinas and public wharves as well as hundreds of private boat launching facilities provide access.

Creel survey data are used for a variety of management and reporting purposes. Catch and effort statistics are used (both inside and outside DFO) to monitor the recreational fishery. In addition, creel survey information is used to predict the effect of regulation changes and to measure the success of conservation actions imposed. Biological data (adipose clip information) collected during the survey are supplied to the Mark Recovery Program (Kuhn et al. 1988) and used in combination with other data for exploitation rate, marine survival and stock distribution analyses.

As part of a broader departmental review of catch monitoring programs, it was considered timely to conduct a review of the Strait of Georgia creel survey design and methodology. In February 2000, a creel workshop was hosted by Fisheries and Oceans Canada and provided an opportunity to review existing recreational fishery surveys and review in some detail the survey design and methodology of the Strait of Georgia creel survey. The workshop had recommended that, among other things, a framework be developed for establishing acceptable levels of precision and a review of the analytical process for generating catch estimates. This report documents a new approach to generating catch estimates as was introduced at that workshop. In addition, there have been several organizational changes that have occurred with regard to the creel survey and recreational fishery data management.

SURVEY OBJECTIVES

The minimum objective for the Georgia Strait Creel Survey (GSCS) has been to provide reliable estimates of the sport angler effort, catches and the adipose-clipped mark rate for chinook and coho salmon by month for Statistical Areas 13 through 19, 28 and 29. Other objectives have been added and removed over the years. Since 1997, the GSCS primary objectives were expanded to include:

1. to estimate the sport angler effort and catches of chinook, coho, chum, pink, sockeye, halibut, lingcod, rockfish (by species) and other finfish by month for Statistical Areas 13 through 19, 28 and 29;

2. to estimate the number of chinook and coho and other salmon released by anglers in the above Statistical Areas;

3. to estimate the catch rate for adipose-clipped chinook and coho in the Strait of Georgia sport fishery; and

4. to estimate the age composition and mean length-at-age for chinook, and the length frequency for chinook and coho caught in the Strait of Georgia sport fishery.

From 1983-1999, the GSCS program has been conducted using the same field design and analytical procedures while funding limitations have significantly reduced the duration of survey and quantity of data collected. At regular intervals of every 2-3 years, GSCS data has been used to identify opportunities for reducing survey cost without impacting survey objectives. In the early years of the survey, analyses focused on the effect of aerial survey timing and interviews per strata on the precision of the resulting catch and effort estimates (English et al. 1986). In addition, the distribution of survey effort among the landing sites and catch regions was assessed each year. In 1988, study design analyses focused on assessing the effect of reductions in the aerial survey and angler interview effort on the precision of the annual chinook catch estimates while maintaining some level of survey effort in each month. By 1992, the monthly survey effort had been reduced to the minimum acceptable levels so program managers chose to eliminate the surveys during the low effort periods (winter months) in order to maintain the reliability of the summer surveys while achieving further reductions in the program budget. By the end of the 1996 field program, the creel survey coverage had been reduced to 7 months and the level of effort expended in aerial survey boat counts and angler interview shifts was 50-60% of that deployed for the annual program prior to 1993. From 1996 to present, complete monitoring of the fishery has been limited to the April-September period (6 months), with additional surveys conducted in October of some years.

METHODS

The Strait of Georgia Creel Survey is comprised of three basic components: angler interview data to derive estimates of catch per effort (CPE) and daily patterns of fishing activity, and aerial surveys to obtain an instantaneous count of boats actively fishing. The analytical procedures used to compute the monthly catch and effort statistics for the Strait of Georgia sport fishery remained effectively unchanged from 1983 to1999 (Shardlow et al. 1989; Hardie et al. 1999). The methods and equations used in the analysis of catch and effort statistics for the 1983-1999 Strait of Georgia creel surveys are provided in Appendix B1.

CATCH PER EFFORT AND ACTIVITY PATTERNS

The data used to compute CPE and daily fishing activity patterns was obtained by interviewing anglers at boat launches and marinas at the end of their fishing trips. Consequently, the units for CPE were the catch by species per boat trip. The fishing activity pattern for each region was estimated by summing the weighted activity patterns for each fishing trip sampled from a group of landing sites on a specific day type in a specific month. The daily fishing activity is described by the portion of the total fishing effort in a strata that was actively engaged in fishing during each hour of the day (see Appendix C).

The access points surveyed (boat launches and marinas) were selected from all available access points based on their geographical distribution and the amount of fishing activity conducted from that site in recent years. Within each geographic region, the busiest access points were selected in order to obtain the maximum number of interviews for each fishing area.

This approach was based on two important observations: 1) CPE tends to be more variable between fishing parties landing at a single access point than between different access points within a geographic area; and 2) CPE and effort can vary substantially both within and between days at a single site. Under these conditions, it is generally agreed that it is better to obtain a large number of interviews covering all temporal strata for a small number of sites than to sample a larger number of sites and obtain fewer interviews and less complete temporal coverage for any specific site. One consequence of making the basic sampling unit the landing site was that both CPE and fishing activity patterns were calculated for groups of landing sites rather than specific fishing locations. Information on the locations fished by the parties landing at a specific site or group of sites was used to determine which CPE estimates and activity patterns should be used to estimate the total monthly fishing effort and catch for each sub-area.

In the early years of the creel survey (1980-1982), the matching of sub-areas with groups of landing sites was based largely on geographic proximity of the landing sites to the fishing areas. In 1982, computer programs were constructed to facilitate the catch estimation process and these programs required input files (match files) that defined the spatial relationship between the fishing sub-areas, regional activity patterns and CPE estimates for groups of landing sites. From 1983-1992, the creel survey managers used formalized procedures to make monthly adjustments to these "match" files using interview data. From 1993-1999, a single "match" file was used for all winter survey months (November-April) and a different "match" file was used to derive the catch and effort estimates for all summer months. In late 1999, analyses were conducted to determine whether sub-area specific CPE estimates could be used to provide a more reliable, less complicated and more robust catch estimation procedure (see section on sub-area CPE estimates).

AERIAL SURVEY BOAT COUNTS

Aerial surveys were used to obtain a count of the boats actively fishing at a specific point in time. This approach was selected because of the magnitude of the fishery, intensity of fishing effort in some areas, and mobility of the vessels. The high cost of an aircraft charter was justified by the amount of data that could be obtained from a large area in a short period of time by a few trained surveyors. The aerial surveys provided more reliable information on the spatial distribution of fishing effort than could be obtained from interviews alone and these data provided an independent check on the coverage of the interview data. In the early years of the creel survey, considerable effort was expended to assess the differences between the distribution of fishing effort extracted from interview and aerial survey data. On several occasions, new landings sites were added to the survey schedule to ensure that the anglers observed in each major fishing area were adequately sampled.

The timing of the aerial surveys has been shown to be very important. The aerial surveys boat counts should be conducted during periods when fishing activity is relatively stable and at least 25-50% of the daily effort can be enumerated (English et al. 1986). The effort estimates become much less reliable when the flights are conducted during periods when the fishing activity is changing rapidly or during off peak periods when expansion factors are large (e.g., each vessel counted represents 10 boat trips). Prior to 1986, the aerial survey routes and schedules were varied to accommodate the different departure locations for DFO and DPA

Consulting Ltd. surveyors. From 1986-1993, annual analyses of the previous years activity patterns for each region and day type were conducted to derive the survey route and timing that would produce the most reliable effort estimate. The consistent use of a single charter aircraft company, departure site and survey route from 1986-1998 resulted in few changes to the aerial survey schedule during these years. However, there were substantial changes in 1998 when DFO once again assumed the responsibility for the aerial surveys and conducted these surveys using Canadian Coast Guard aircraft. The increased potential for substantial differences in the timing of boat counts between aerial surveys necessitated changes to the procedures used to estimate fishing effort.

ASSESSMENT OF THE EFFECT OF SURVEY EFFORT ON PRECISION

From 1983 to 1987, the precision goal for the Strait of Georgia creel survey program was $\pm$5% for the 95% confidence interval of the annual chinook catch estimate. This goal was achieved in most of these years. In 1988, the need to reduce survey costs resulted in a request to creel survey program managers to prepare a creel survey design that would provide reliable annual chinook catch estimates with precision goal of $\pm$ 20%. The effect of alternative levels of survey effort on precision was assessed using the 1987 creel survey data for March, May and July. These months were chosen to represent three categories of sport fishing: March being representative of winter fishing (October-April); May being representative of the transition between winter and summer fishing (May, June and September); and July being representative of summer fishing (July and August). Both angler activity and survey effort vary substantially between these fishing periods (Figures 4 and 5). Our analysis approach involved extracting sub-sets of the 1987 interview and aerial survey data for each month and calculating the monthly chinook catch and standard error statistics from the randomly selected data. These analyses included a variety of reductions in survey effort and the analysis programs kept track of number of shifts, number of angler interviews and chinook seen by catch region. Reductions in interview effort were simulated by:

1. deleting specific survey sites;
2. deleting a portion of the shifts in each stratum (25-50%); or
3. both (deleting specific sites and deleting a portion of the shifts at each of the remaining sites).

The impact of reducing aerial survey effort was tested by:

1. reducing the number of surveys (summer only); or
2. decreasing the survey coverage (i.e., fly only the southern flight route in winter months).

The relative change in the chinook standard error statistic for each month type was then applied to the other months of that type to estimate the precision for the annual chinook catch estimate. The results from these analyses were compiled into three options for the implementation of the 1988 creel survey.

RESULTS & DISCUSSION

SAMPLING EFFORT AND PRECISION

Table 2 shows the chinook harvest estimates and associated levels of precision for several different combinations of survey effort reductions for the March, May and July survey periods. The base case (BASE) option for each month reflects the actual survey effort, number of fishermen interviews, and chinook catch and standard error (STE) estimates for that month in 1987 (Option A). The results in bold print reflect an intermediate level reduction to the 1987 angler interview and aerial survey effort while maintaining a year round creel survey with complete coverage of all fishing areas for the summer fishery but limit coverage to the major fishing areas during the winter fishery (Option B). The last sampling level under each month was derived by further reducing Option B to the minimum amount of survey effort required to conduct at least two shifts in each survey stratum (Option C). The number of survey strata per month was determined by the number of landing sites surveyed, the need to sample from each day type (weekend, mid-week days), and the number of shifts required to cover daily fishing activity. This equated to roughly 60 shifts for winter months (October-April), to conduct 2 shifts on each day type for each of 15 landing sites (2x2x15). During peak summer months (June-August), a minimum of 120 shifts were required to schedule 2 shifts for each AM/PM – day type combination for 15 sets of landing locations (2x2x2x15). In May and September, the minimum survey level was set at 100 shifts per month.

In general, reductions in survey effort for May and July resulted in a roughly proportional reduction in the precision of the resulting catch estimates. However, results for March show that, when catch rates are highly variable, reductions in sampling effort could reduce or improve precision. With regard to accuracy, none of the effort reductions for May and July resulted in any significant bias in the 1987 chinook catch estimate. The chinook catch estimates for the March options which exclude interviews and aerial survey data for the northern waters of Georgia Strait (March Option R4 and R5) would have to be expanded by dividing estimates for the southern regions by the proportion of the catch that has historically been taken in Southern Georgia Strait in each winter month (84% in winter 1987, 80% in winter 1986).

Table 3 shows the precision levels associated with the monthly and annual catch estimates for chinook for each of the three survey options. For Option A, the 95% confidence interval for the 1987 monthly chinook catch estimates range from $\pm$11.4% for the August catch to $\pm$ 43.6% for the March harvest estimate. Despite the poor precision for most of the catch estimates for winter months, the precision associated with the annual catch estimate for chinook was a very acceptable $\pm$6.1%. Under Option B (roughly a 30% decrease in the survey effort), the precision estimated for the annual catch of chinook was $\pm$7.7%. Under Option C (a 61% reduction in angler survey effort and a 50% reduction in aerial survey effort), the precision level for the annual chinook estimate was $\pm$8.5%.

Table 4 shows the relative survey costs and the estimated number of chinook available for biosampling for each level of survey effort (Option A, B and C). Option C provided the greatest cost savings and achieved the desired levels of precision in the chinook catch estimate. However, Option C was not recommended because the substantial reduction in the number of

chinook that would be encountered for biosampling and mark incidence information (41% of 1987) would compromise these ongoing databases. Option B was recommended because it provided adequate cost savings along with access to more chinook (77% of 1987) and better precision than Option C.

STATISTICS VERSUS LOGISTICS

The purpose of the above analysis was to reduce program costs by relaxing the precision goal for the chinook catch estimate from +5% to ±20%. However, it was factors other than statistical precision that determined the minimum amount of interview survey effort for a given month or region. One of these factors was the quality of interview staff. We have found that it is difficult to hire and retain quality surveyors for part-time positions. Quality surveyors have more options for employment and have little interest in a part-time creel survey job. Since full-time work equates to roughly 20 shifts per month to cover 2-5 survey sites, this has defined the logistical minimum sampling level to obtain quality data from a catch region. Another significant factor has been the need to obtain age and tissue samples from the chinook catch. With the decline and eventual closure of the commercial troll fishery in Georgia Strait, sport fishery surveys became the only opportunity to obtain age and stock composition samples. In fact, it was DFO's chinook biosampling goals that maintained the interview survey effort at or above the 1987 effort level from 1988 through 1992 (Figure 6). After 1992, cost cutting efforts focused on the number of months surveyed each year rather than reducing the sampling in a given month to a statistical or logistical minimum.

It is important to note that with the reduction in total catch and coverage of the fishery, it is essential to maintain coverage that will provide sufficient chinook biosampling opportunities to ensure that the integrity of the coded-wire tag recovery information is not further eroded.

SURVEY CHANGES 1983-1999

Catch and effort estimates derived from the 1980-1985 GSCS programs have been documented in several published and unpublished reports (DPA 1981, Shardlow et al. 1989; Shardlow and Collicutt 1989a;1989b;1989c;1989d;1989e). However, detailed summaries of the number of shifts, interviews and aerial surveys conducted by month are not available in these reports. In 1986, changes were made to the data management system used to organize and analyze the GSCS data. These changes resulted in the preparation of comprehensive data summaries and unpublished reports that are available for each month when the surveys were conducted by LGL Limited (April 1986 through September 1999). Information from these reports has been compiled to examine annual variation in survey effort and the precision of the catch and effort estimates over this 14-year period.

Despite the continuous pressure to reduce survey costs and evaluate alternative allocations of survey effort, the GSCS program remained fairly constant from 1986 and 1990 (Figures 6 and 7). The levels of survey effort deployed in these years was reduced from that of the 1980-1981 survey, but was similar to the 1982-1985 levels. In 1991 and 1992, survey costs were reduced by decreasing the number of aerial surveys conducted in summer months while retaining a year round sampling program (Figure 7). In 1993, the survey coverage was reduced

to 9 months (January-September) because these months represented 93% of the chinook and 95%-99% of the other salmon species caught in the Georgia Strait sport fishery between 1987 and 1992 (Table 5). Initial plans for 1994 were similar to 1993, however, declines in coho catches and the observation that 5% of the annual catch has been taken in October lead to the expansion of the 1994 survey to include October. Since 1994, no creel surveys have been conducted during the November-February period and 1995 marked the last year that data was collected for March. The October sport fishery was monitored in 1997 and 1998 but reduced to cover only the Victoria area in 1999. The total catch and effort estimates for each of these partial survey years (Table 1) were calculated by expanding the survey estimates for sampled months using the portion that these months represent of the annual totals (Table 5). Given the substantial changes in the sport fishery over the past 10 years, the 1987-1992 annual patterns of sport fishing activity are probably no longer appropriate for expanding the estimates for surveyed months.

In order to examine the trends in survey effort (number of shifts) and the number of interviews conducted, we summarized these statistics for the months when the entire fishery was surveyed (April-September) each year from 1986-1999. These statistics show a slight decrease in the number of survey shifts between the years before and after 1992, but a major decline in the number of interviews from over 30,000 in 1992 to less than 15,000 in 1998 and 1999 (Figure 8). This reflects the decline in total fishing effort from over 500,000 boat trips in 1992 to less than half that number in recent years (Figure 1). The number of aerial surveys conducted during the April-September period was 47-48 prior to 1991, reduced slightly in 1992 and held constant at the minimum recommended level of 34-35 flights from 1993-1999 (Figure 9).

The precision of the effort estimate, expressed as a coefficient of variation (CV), has been less than 3.3% in every year, except 1992 and 1995 (Figure 10). The poor precision in these two years was due to aerial survey timing and large variation in the boat counts in Statistical Area 14 during a single month in each year. In July 1992, the activity pattern used to estimate effort for Area 14 (Comox Central region) showed that very few boats were fishing on week days during the time when the aerial boat count was conducted. This coupled with high variability in the boat counts between surveys resulted in what was probably an overestimate of the fishing effort (45,000 boat trips) and a CV of 68% for the July fishery in Area 14. In contrast, CV for the adjacent Campbell River fishing region (Area 13) was 7% for an effort estimate of 25,000 boat trips in July 1992. In 1995, the poor precision was due to a similar circumstance occurring in September that resulted in a CV of 95% for the effort estimate of 20,686 boat trips for Area 14. The very poor precision of these effort estimates for Area 14 resulted in CV's of 25% and 31% for the estimates of total effort for July 1992 and September 1995, respectively. The average CV's for the 1990-95 effort estimates, excluding the anomalous years, was 4.9% for July and 5.1% for September (Appendix Table D1). This clearly demonstrates that inappropriate aerial survey timing for a single Statistical Area in a single month can have a substantial effect on the precision of the annual effort and catch estimates. It is also likely that these problems resulted in a positive bias in both the effort and catch estimates. Area 14 typically represents 17% and 20% of the total effort for the Strait of Georgia recreational fishery in July and September, respectively. In July 1992, Area 14 effort estimate represented 37% of the total fishing effort and in September 1995 Area 14 effort estimate was 31% of the total fishing effort for that month.

The CV for the April-September chinook catch estimate was consistently less than 3.3% prior to 1990 but has been consistently higher and ranged between 3.3% and 8.8% from 1991-1999 (Figure 11). The poor precision associated with the chinook catch estimate for 1992 (CV of 5.3%) and 1995 (CV of 8.8%) was largely the result of variability in the effort estimate, while the primary factors that determined the precision achieved in other years were the number of interviews and size of the chinook catch (Appendix Table D2). Precision tends to decrease (i.e. larger CV's) as catches get smaller. The most precise chinook catch estimate was computed in 1984 when the April-September catch was over 330,000 (CV of 2.3%). The record low catch of 21,000 chinook in 1998 had a CV of 6.1%.

The effect of catch size on the precision was even more apparent for coho. Prior to 1996, the CV's for coho where similar to those for chinook (averaging 4.0%). In 1998 and 1999, when the annual coho catch estimates were 1,833 and 476 fish, the CV's for these estimates were 13.6% and 17.5%, respectively (Appendix Table D3). However, these precision estimates must be kept in perspective, since a CV of 17.5% on a catch estimate of 476 is equivalent to a 95% confidence interval of $\pm$170 fish (Appendix Table D3). In absolute numbers, the more recent catch estimates are far more precise than those obtained when the total annual harvests were consistently above 380,000 coho and 90,000 chinook in the 1980's.

PROGRAM REVIEW 2000

In the later part of 1999 and early 2000, we conducted a series of analyses on the 1998 and 1999 creel survey data in order to determine if changes should be made to some components of the study design and data analyses system. These analyses included:

1. analysis of recent activity pattern data to identify the optimal aerial survey times for each survey area;

2. testing an analysis system that accommodates within month variability in aerial survey timing;

3. the design and testing of an analysis system that uses sub-area specific CPE estimates to compute the catch estimates for each sub-area; and

4. comparison of the catch and effort estimates generated using the above alternative aerial survey analysis approach and CPE estimation approach with those estimated using the historical estimation procedures.

The following sections provide a summary of our findings with respect to each of the above analyses.

ACTIVITY PATTERN ANALYSIS

Our most significant findings with regard to fishing activity patterns were the number of strata where the sample sizes were not adequate or were marginally adequate to define a reliable activity pattern. As a general rule, more than 50 interviews of active anglers are required to

define an activity pattern for a strata (area, month, day type combination). Figure 13 provides examples of activity patterns derived from 50 or more interviews and those obtained from less than 15 interviews. In 1998 and 1999, Victoria was the only fishing area where the number of angler interviews consistently exceeded the sampling goal of 50 interviews (Tables 6 and 7). In 1998, sample sizes were less than 50 in half of the strata and less than 15 in 25% of the strata. The findings for 1999 were only slightly better, 40% with less than 50 interviews and 22% with less than 15 interviews. The major problem areas in both years were Stuart Island (STU) and Saanich Inlet (SAN) due to unusually low numbers of fishing trips. There were no month-day type combinations when the sample sizes were adequate to compute an activity pattern for the Stuart Island area. Sample sizes were consistently low (<15 interviews) for the Saanich Inlet strata in May and June and only marginally better in July and August. Other areas with marginal sample sizes in 1998 included Comox (COC) and Sechelt (SECH). An increase in fishing activity in the Sechelt area in 1999 substantially improved the sample size and reliability of the resulting activity pattern.

Appendix Figures C1 to C8 show the daily fishing activity patterns for each of the major fishing months and the aerial survey timing. In most areas, the activity patterns have not changed substantially since 1993. However, there have been substantial changes in the timing of aerial surveys and in several strata where the current time does not coincide with peak fishing activity.

Unfortunately, it is not possible to time overflights to survey each area at the optimal time since the peak timing of each region varies considerably from each other. Therefore, for logistical reasons, the flight route must be selected and the optimal timing of the entire route must be selected. An assumption was made that overflights would be conducted with only one aircraft originating in Vancouver. Three route options were considered. Option 1 begins in Vancouver, heads north along the mainland coast to Stuart Island and then south along the Vancouver Island coast ending in Victoria. Option 2 begins in Vancouver, heads across to Victoria then north along the Vancouver Island coast to Stuart Island then back to Vancouver along the mainland coast. Option 3 begins in Vancouver, heads across to Victoria then north along the Vancouver Island coast to Nanaimo then across to the mainland coast heading north to Stuart Island then south along the Vancouver Island coast ending in Qualicum. The optimal timings for each of these options were obtained from activity patterns developed for each month and day type (i.e., weekday and weekend) from data collected during 1998 and 1999. Appendix E presents a summary of the results for each aerial survey option showing the mean portion of the daily fishing effort and percent of the maximum hourly effort that is actively fishing at the time of the aerial survey count, for each day type and survey month. Based on those data the Option 2 route is the recommended route and is thought to be marginally superior to Option 3 and considerably better than Option 1. Option 2 survey times are better than Option 1 for most areas and substantially better for the intensive fisheries off the Victoria waterfront. Option 3 survey times are slightly better than Option 2 but the flight path for Option 3 would be longer than Option 2. Table 8 provides the recommended survey timing based on the 1998 and 1999 activity pattern data.

VARIABILITY IN AERIAL SURVEY TIMING

The amalgamation of Canadian Coast Guard operations with the Fisheries and Oceans, Canada (FOC) in 1997 provided an opportunity to use Coast Guard aircraft to obtain the aerial survey boat counts required to the current GSCS program. However, scheduling difficulties have resulted in substantial variability in the times that aerial boat counts were conducted in some or all sub-area. This variability in survey timing can have a significant impact on the effort estimate.

Prior to 1998, flights were scheduled to coincide with peak or close to peak fishing activity in each fishing area, and all counts for each fishing area were conducted at roughly the same time within a month. Monthly effort estimate for each stratum was computed by calculating the mean monthly boat count for a strata and dividing by the proportion of the daily fishing effort that was actively fishing during the time of the boat count.

The modifications required to accommodate variable timing of boat count surveys were implemented for the Haida creel survey program in 1997. In the Haida program, activity pattern data from angler interviews were combined with opportunistic on-water boat counts to derive an estimate of fishing effort. When the boat counts are conducted at different times the individual survey counts must be divided by the proportion of boats active at the time of the survey to compute an effort estimate for that survey day. The total effort estimates for each survey day are then combined to derive a mean daily effort estimate for each sub-area and day type stratum. The monthly effort estimate for each stratum is computed by multiplying the mean daily effort by the number of days of that day type in that month.

As expected, these changes had no effect on effort estimates where counts were consistently conducted at the same time or during periods when the activity pattern proportions were constant (Appendix F). However, the effect on effort estimates can be substantial when counts are conducted on each side of a peak or valley in the daily fishing activity pattern (see the Area 15 efforts estimates for September). Given the potential for variability in the timing of future aerial surveys, we recommend that the "new" analysis approach be used to compute the estimate for fishing effort.

SUB-AREA CATCH PER EFFORT ESTIMATES

The initial GSCS design was based on the landing site. Data from several nearby landing sites were combined to compute a mean CPE estimate for a landing group. These CPE estimates were matched to the sub-area using information on the sub-areas fished by anglers landing at the sites within each group. Programs were written to identify all the sub-areas fished from a specific group of landing sites and design month specific match files. However, it appears that these programs have not been used by FOC in recent years. Instead, a single match file has been consistently used for all summer months (April-September) and another match file has been consistently used for winter months (October-March).

The idea of using sub-area specific CPE has been proposed on several occasions since the mid-1980's, but the funds required to assess the potential for this approach were not available

prior to these investigations. The combination of sub-area CPE estimates with sub-area effort estimates is a much simpler analysis approach than the historical catch estimation program. However, this approach did require major modifications to the current data summary and analysis programs that were all based on landing site strata. In addition, procedures had to be developed to define the CPE estimates to be used when no CPE estimates are available for a specific sub-area or sample sizes are very small.

The approach we tested for this project involved computing three levels of CPE estimates that could be combined with the sub-area effort estimates depending on sample size. The three levels were: 1) CPE for a specific sub-area; 2) CPE for adjacent sub-areas usually within the same statistical area; and 3) CPE for two or more groups of level 2 sub-areas. Figure 14 shows the spatial resolution associated with each level of sub-area groups. A detailed list of the sub-areas and sub-area grouping for each of the three levels is provided in Table 9. Level 1 CPE was used if there were more than 5 interviews that reported fishing in that sub-area. Level 2 CPE was used when the available data was not sufficient for Level 1 and the Level 2 CPE estimate was based on more than 5 interviews. Similarly, Level 3 CPE was used when the available data was not sufficient for either Level 1 or 2, and the Level 3 CPE estimate was based on more than 5 interviews. If Level 3 CPE was based on less than 5 interviews, no catch estimate would be computed for that strata and the program would provide a warning that sample sizes were too low to compute a CPE estimate for that sub-area. In the data examined, there were no instances where Level 3 CPE estimates were based on less than 5 interviews.

The total catch estimates for 1998 derived using the "old" landing group CPE methodology were generally similar to those derived using the "new" sub-area CPE approach (Figure 15, Appendix G). A major exception was for coho where the new total catch estimate (2,107) was substantially higher than that derived using the historical approach (611). This difference was largely due to the "old" method using the wrong group landing site CPE for one of the sub-areas in Statistical Area 28 in August 1998 (Appendix Table G1 and G4). Detail examination of this discrepancy revealed that 93% of the fishing effort in Area 28 occurred in sub-area 28A (southern portion of Howe Sound) in August 1998. The "old" method failed because the fishing pattern changed in August 1998 and the data file that matched the landing groups with the fishing areas (i.e., the match file described above) was not updated to capture this change. Historically, most of the fishing effort in sub-area 28A originated from landing sites in the Vancouver West (VAW) landing group. In August 1998, essentially all of the vessels fishing in sub-area 28A landed in the Vancouver (VAN) landing group. This would not have created a problem if the CPE values were similar for these to adjacent landing groups. However, in August 1998, the 196 boat trips sampled in the VAN landing group had an average coho CPE of 0.23 fish per boat trip while no coho were reported caught for the 45 boat trips that were interviewed at sites in the VAW landing group. Using the "new" sub-area CPE approach, we found that a total of 181 boat trips fished in Area 28A and their average CPE was 0.27 coho per boat trip. Clearly, the "new" approach provided a better estimate of the true coho catch in Area 28 than the "old" approach when the fishing patterns are assumed to be constant over time.

Similar comparisons of catch estimates for 1999 revealed substantial differences between the two analysis approaches for several species (Figure 16, Appendix H). For some statistical areas, the catch estimates increased while in others the estimates decreased. However, in every

instance examined the "new" approach provided the more defensible estimate than the "old" approach because sub-areas with high levels of fishing effort had CPE values that were substantially different from those for the previously used landing group. Differences at the sub-area level were even more substantial than those at the statistical area level. As a general rule, sub-area catch estimates based on Level 1 or 2 CPE should be more accurate than those estimates derived using the "old" approach. All sub-area catch estimates based on the "old" approach or on Level 3 CPE in the "new" approach should be considered highly uncertain.

An additional change in the "new" approach is the removal of the factors used to weight the CPE estimates for each landing site to account for the portion of the boat trips interviewed and the number of interview shifts per work block (see Appendix B1). While these weighting factors are still important for defining accurate activity patterns, they should not be included in the CPE estimation process. The previous weighting system gives higher weights to strata with smaller sample sizes and thus poor sampled sub-areas could bias the CPE estimates when the data from several sub-areas must be combined to achieve the minimum sample size requirement of five interviews for a CPE estimate. The most important factors in the "new" approach are: the number of boat trips that include fishing activity for a specific sub-area, the similarity in CPE between adjacent sub-areas, and obtaining a large representative sample from each of the major fishing areas.

The removal of the weighting factors also made it simpler to compute the precision for each catch and effort estimate. The "new" procedures for estimating variance are similar to those used for the "old" method (Shardlow et al. 1989) and other catch monitoring programs (Bocking and English 1993; English et al. 1986, 1997). Appendix B2 provided the equations required for computing the variance for the fishing effort and CPE estimates and the standard errors for the total catch and effort estimates derived using the "new" approach.

In general, the precision associated with the 1998 catch estimates derived using the "new" analysis approach were very similar to those derived using the "old" approach (Figure 17, Appendix G). Precision was marginally improved for the coho, chinook and lingcod catch estimates and slightly poorer for the pink and sockeye catch estimates. A comparison of the results for 1999 data revealed similar consistency in the estimates of precision (Figure 18, Appendix H).

CONCLUSIONS

The creel survey has undergone numerous reviews over the years and many analyses have been conducted to assess the effect of reducing sampling effort on the precision of the catch estimates. Analyses conducted in 1988 clearly showed that relatively high levels of precision (95% confidence intervals of less than $\pm$10% of the chinook catch estimate) could be achieved with substantial reductions in survey effort in high effort years. However, the practical logistics associated with the coverage of the survey (number of survey locations in each region and the distance between these locations) and the need to provide full-time jobs to obtain quality surveyors were the major factors determining the minimum acceptable level of angler interview

survey effort. Despite these constraints, substantial reductions in survey costs have been achieved by streamlining all survey components (i.e. hiring, training, data entry, analysis, supervision), reducing the number of aerial surveys per month and the number months covered by the survey.

The precision of the effort estimate, expressed as a 95% confidence interval, has been less than ±6% in every year, except 1992 and 1995. The poor precision in these two years was due to aerial survey timing and large variation in the boat counts for a specific month-statistical area stratum. The precision of the annual chinook catch estimate was consistently less than ±6.6% prior to 1990 but subsequent estimates have been less precise and ranged between ±6.6% and ±17.6%. The primary factors that determined the precision of the chinook catch estimates after 1990 were the number of interviews and size of the chinook catch. The precision of the annual coho catch estimates were similar to those for chinook prior to 1998. The precision of the coho catch has declined substantially with the size of the total catch. In 1998 and 1999, when the annual coho catch estimates was less than 2,000 fish, the 95% confidence intervals were ±27% and ±35%, respectively.

The changes in the Strait of Georgia sport fishery and GSCS implementation in recent year precipitated a review of the study design and data analysis systems in 2000. The review found that declines in fishing activity were having a significant impact on the estimates of the daily fishing activity pattern for several areas. Also, changes to the data analyses procedures were required to accommodate the increased variability in aerial survey timing resulting from the shift from charter aircraft to Coast Guard aircraft. Additional analyses were conducted to assess the benefits of using sub-area specific CPE rather than group landing site CPE to compute the catch estimates. Comparisons of catch estimates for 1998 and 1999 revealed substantial differences in the estimates derived from the two analysis approaches for some species. The "old" approach could produce inaccurate catch estimates for specific fishing areas, when the link between the fishing location and the landing site is not examined and up dated each month. The "new" analytical approach describe in this report is much more robust to changes in fishing patterns and the distribution of survey effort than "old" data analysis procedures.

Despite the numerous challenges faced over the past 19 years, the Strait of Georgia Creel Survey has been one of the most consistently implemented and successful catch monitoring programs conducted in Canada. The survey has provided some of the most reliable and precise catch estimates available for any recreational fishery. For many years, in-season catch estimates were available to fisheries managers within seven days of the end of each sampling period. Survey costs have been reduced substantially from 1983 to 1999 while maintaining the quality of the catch and effort estimates for all months surveyed.

RECOMMENDATIONS

1. maintain the interview survey effort at or above current levels to ensure that most activity patterns are derived from more than 50 interviews;

2. do not use activity patterns derived from less than 15 interviews to compute effort estimates for a specific sub-area;

3. use the "new" effort estimation analysis approach to compute estimates for fishing effort by sub-area;

4. use the "new" sub-area CPE analysis approach to compute catch estimates for each sub-area;

5. ensure that the detailed monthly catch and effort estimates are reviewed by the field program manager and at least one senior analyst familiar with the study design; and

6. maintain sufficient coverage of total catch to meet biosampling requirements for fishery assessment purposes.

LITERATURE CITED

Bocking, R.C. and K.K. English. 1993. Nisga'a catch monitoring program, 1992 Nisga'a fishery. Report NF 92-03 prepared by LGL Ltd., Sidney, BC, for the Nisga'a Tribal Council, New Aiyansh, BC.

Cochran, W.G. 1963. Sampling Techniques. John Wiley & Sons.

DPA Consulting Limited. 1981. 1980-81 Georgia Strait Sport Fishing Creel Survey, Draft Final Report.

English, K.K., W.B. Griffiths, A.C. Gurak, M.E. Jarvis, and J. McKenzie. 1997. Yukon River drainage basin harvest study 1996. Report prepared by LGL Ltd., Sidney, BC for the Yukon River Basin Harvest Study Steering Committee, Council of Yukon First Nations, and Department of Fisheries and Oceans, Whitehorse, Yukon.

English, K.K., T.F. Shardlow, and T.M. Webb. 1986. Assessment of the Strait of Georgia sport fishing statistics, sport fishing regulations and trends in chinook catch using creel survey data. Can. Tech. Rep. Fish. Aquat. Sci. No. 1375. 53 p.

Hardie, D.C., D.A. Nagtegaal, and L. Nagy. 1999. Strait of Georgia sport fishery and Northern Vancouver Island creel survey statistics for salmon and groundfish, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2500: 92p.

Kuhn, B.R., L. Lapi, and J.M. Hamer. 1988. An introduction to the Canadian database on marked Pacific salmonids. Can. Tech. Rep. Fish. Aquat. Sci. 1649: viii + 56 p.

Shardlow, T.F. and L.D. Collicut. 1989e. Strait of Georgia sport fishery creel survey statistics for salmon and groundfish, 1988. Can. MS Rep. Fish. Aquat. Sci. 2036:63 p.

Shardlow, T.F. and L.D. Collicut. 1989d. Strait of Georgia sport fishery creel survey statistics for salmon and groundfish, 1987. Can. MS Rep. Fish. Aquat. Sci. 2035:62 p.

Shardlow, T.F. and L.D. Collicut. 1989c. Strait of Georgia sport fishery creel survey statistics for salmon and groundfish, 1986. Can. MS Rep. Fish. Aquat. Sci. 2034:61 p.

Shardlow, T.F. and L.D. Collicut. 1989b. Strait of Georgia sport fishery creel survey statistics for salmon and groundfish, 1985. Can. MS Rep. Fish. Aquat. Sci. 2033:60 p.

Shardlow, T.F. and L.D. Collicut. 1989a. Strait of Georgia sport fishery creel survey statistics for salmon and groundfish, 1984. Can. MS Rep. Fish. Aquat. Sci. 2032:61 p.

Shardlow, T.F., K.K. English, T. Hoyt, G.E. Gillespie, and T.A. Calvin. 1989. Strait of Georgia creel survey sport fishery statistics, 1983. Can. MS Rep. Fish. Aquat. Sci. 1872:53 p.

TABLES

Table 1. Annual fishing effort and catch estimates for the Strait of Georgia recreational fishery, 1983-1999. (a)

		Catch Estimates					
YEAR	EFFORT	Coho	Chinook	Pink	Sockeye	Rockfish	Lingcod
1983	574,263	404,033	198,425	54,820	(b)	185,381	62,770
1984	651,088	443,589	369,442	10,241	(b(	158,678	137,485
1985	628,516	728,203	234,842	90,515	15 (c)	134,115	77,113
1986	582,971	571,983	181,902	3,145	918	167,786	70,820
1987	589,631	641,572	121,088	90,004	8,867	136,270	65,810
1988	664,370	1,084,580	118,985	8,875	16,403	194,784	65,929
1989	603,331	497,223	132,846	123,046	13,356	199,898	52,329
1990	542,566	629,409	111,773	11,549	30,669	154,739	31,376
1991	466,749	157,111	115,522	249,662	23,521	171,891	8,251
1992	467,559	595,553	116,579	19,085	6,745	135,763	5,968
1993 (d)	530,945	882,875	128,342	173,425	23,814	111,598	7,175
1994 (e)	471,889	297,520	77,265	18,466	14,054	163,768	6,996
1995 (f)	338,431	86,787	71,471	183,938	5,897	116,662	4,899
1996 (g)	323,333	136,897	109,152	7,779	2,365	114,143	3,901
1997 (h)	287,791	106,877	67,222	111,124	16,887	92,543	4,152
1998 (h)	173,761	1,867	24,967	6,848	4,474	89,152	3,345
1999 (g)	183,120	485	55,563	27,832	488	70,184	3,688
Mean	475,313	427,445	131,493	70,021	12,033	141,021	36,000

(a) 1983-1988 Shardlow and Collicut, 1988; 1989-1999 from DFO recreational fishery reports.

(b) sockeye estimate not available

(c) sockeye estimates incomplete

(d) catch and effort extrapolated to 12 month estimate using data for January - September

(e) catch and effort extrapolated to 12 month estimate using data for January - October

(f) catch and effort extrapolated to 12 month estimate using data for March - October

(g) catch and effort extrapolated to 12 month estimate using data for April-September

(h) catch and effort extrapolated to 12 month estimate using data for April-October

Table 2. Example of the effect of survey reductions on the precision (95% confidence interval) of the monthly chinook catch estimates for March, May and July 1987.

Option	Number of flights	Sites Deleted	Shifts Deleted	Shifts	Number of Interviews	Chinook Sampled	Chinook Catch Est.	STE	Precision
March									
BASE	4	0	0%	132	991	395	3461	779	44.1%
RUN 1	4	0	25%	123	921		3310	672	39.8%
RUN 2	4	0	33%	111	833		3928	883	44.1%
RUN 3	4	0	50%	78	586		3291	528	31.4%
RUN 4	4S	4	0%	104	898	361	3080	777	49.4%
RUN 5	4S	4	50%	78	454	164	2843	782	53.9%
May									
BASE	7	0	0%	265	2714	746	20066	1803	17.6%
RUN 1	7	0	50%	140	1409		21927	2344	21.0%
RUN 2	7	10	0%	184	2097		18430	1799	19.1%
RUN 3	5	10	0%	184	2097	540	20654	2215	21.0%
RUN 4	5	10	50%	97	1130	334	21128	2788	25.9%
July									
BASE	11	0	0%	308	4911	801	18689	1325	13.9%
RUN 1	11	0	25%	259	4125		19945	1536	15.1%
RUN 2	11	0	33%	245	3905		19649	1525	15.2%
RUN 3	11	0	50%	162	2810		18918	1628	16.9%
RUN 4	7	0	0%	308	4911		19907	1809	17.8%
RUN 5	7	0	50%	162	2810		20265	2101	20.3%
RUN 6	7	11	0%	222	3787	597	19682	1874	18.7%
RUN 7	11	11	0%	222	3787		18492	1399	14.8%
RUN 8	11	11	50%	118	2130		17978	1590	17.3%
RUN 9	7	11	50%	118	2130		19135	2015	20.6%
RUN 10	6	11	50%	118	2130		19616	2061	20.6%
RUN 11	4	11	50%	118	2130	303	19350	2150	21.8%

Table 3. Example of the effect of three options for survey reductions on the precision of the monthly and annual chinook catch estimates derived from the analysis of the 1987 creel survey data.

	Chinook	Standard Error			95% Confidence Interval (±%)		
Month	Catch	Option 1	Option 2	Option 3	Option 1	Option 2	Option 3
Jan/Feb	11269	1483	1679	1831	25.8%	29.2%	31.9%
Mar	3431	764	865	944	43.6%	49.4%	53.9%
Apr	5788	595	673	735	20.1%	22.8%	24.9%
May	20066	1802	2150	2652	17.6%	21.0%	25.9%
Jun	27630	2052	2764	3222	14.6%	19.6%	22.9%
Jul	18689	1324	1783	2079	13.9%	18.7%	21.8%
Aug	18596	1083	1459	1700	11.4%	15.4%	17.9%
Sep	9370	611	729	899	12.8%	15.2%	18.8%
Oct	3081	418	473	516	26.6%	30.1%	32.8%
Nov/Dec	3161	357	404	441	22.1%	25.1%	27.3%
Total	121081	3768	4744	5539	6.1%	7.7%	9.0%

Table 4. Summary of the estimated survey costs, survey effort and precision of the annual chinook catch estimates relative to the observed results from the 1987 Georgia Strait Creel Survey.

Option	Total Survey Cost	Aerial Survey Effort	Interview Effort		Chinook Seen	Precision of Chinook Catch (95% CI)
			Shifts	Interviews		
A	100%	100%	100%	100%	100%	6.1%
B	78%	73%	72%	79%	77%	7.7%
C	55%	35%	42%	43%	41%	9.0%

Table 5. Means and standard errors for the percent of total catch and effort occurring in each survey month or sequence of months (1987-92).

Month	Effort	Coho	Chinook	Pink	Sockeye	Rockfish	Lingcod
Mean Percent							
Jan	1.2	0.3	3.7	0.0	0.0	0.9	0.1
Feb	1.2	0.3	3.7	0.0	0.0	0.9	0.1
Mar	2.2	1.1	3.2	0.0	0.0	1.8	0.2
Apr	3.5	5.0	3.9	0.0	0.0	3.2	1.9
May	11.3	11.5	14.9	0.9	0.0	12.6	12.6
Jun	16.9	22.8	23.7	6.1	1.2	16.2	20.3
Jul	23.1	26.6	18.1	15.6	21.1	26.7	23.7
Aug	21.6	14.7	14.6	52.2	60.6	20.4	22.0
Sep	12.9	12.8	6.9	24.7	16.2	10.6	14.0
Oct	4.1	4.8	1.8	0.4	0.9	4.9	3.9
Nov	1.0	0.1	2.8	0.0	0.0	1.0	0.7
Dec	1.0	0.1	2.8	0.0	0.0	1.0	0.7
Jan.-Sep.	93.8	95.0	92.6	99.6	99.1	93.2	94.8
Mar.-Oct	95.6	99.3	87.0	100.0	100.0	96.3	98.6
Apr.-Oct.	93.4	98.2	83.8	100.0	100.0	94.5	98.4
Apr.-Sep	89.3	93.4	82.0	99.6	99.1	89.6	94.5
May-Sep.	85.8	88.4	78.1	99.6	99.1	86.4	92.6
Standard Error							
Jan	0.11	0.09	0.58	0.00	0.00	0.07	0.04
Feb	0.11	0.09	0.57	0.00	0.00	0.07	0.04
Mar	0.24	0.36	0.48	0.00	0.00	0.31	0.06
Apr	0.37	1.33	0.68	0.01	0.00	0.22	0.82
May	0.25	2.29	1.27	0.79	0.01	1.24	3.29
Jun	0.49	4.14	1.79	5.02	0.41	1.01	1.54
Jul	1.36	1.95	1.17	4.33	6.78	1.86	1.90
Aug	0.99	1.64	0.85	6.40	6.22	1.43	2.15
Sep	1.44	5.16	0.88	9.44	3.54	1.55	2.49
Oct	0.67	2.86	0.31	0.26	0.67	1.07	1.09
Nov	0.18	0.03	0.67	0.00	0.00	0.28	0.28
Dec	0.18	0.03	0.67	0.00	0.00	0.28	0.28
Jan.-Sep.	0.64	2.86	1.13	0.00	0.67	1.07	1.57
Mar.-Oct.	0.51	0.22	2.04	0.00	0.00	0.58	0.53
Apr.-Oct.	0.50	0.46	2.04	0.00	0.00	0.62	0.58
Apr.-Sep.	0.57	2.54	1.87	0.00	0.67	0.83	1.61
May-Sep.	0.51	2.32	1.77	0.00	0.67	0.88	1.93

Table 6. Sample size used to derive the daily fishing activity pattern for each survey stratum, 1998.

	May	Jun	July	Aug
Weekdays				
CAM	40 *	165	178	181
COC	2 **	60	21 *	12 *
QUL	46 *	68	94	113
NAN	35 *	134	150	167
SAN	3 **	7 **	3 **	4 **
VIC	62	172	156	184
STU	0	5 **	3 **	5 **
SECH	8 **	24 *	20 *	21 *
VAN	25 *	23 *	50	67
Weekend Days				
CAM	75	208	176	309
COC	15 **	33 *	17 *	15 *
QUL	61	97	41 *	122
NAN	143	171	87	207
SAN	5 **	4 **	4 **	16 *
VIC	137	266	161	275
STU	0 **	5 **	7 **	3 **
SECH	35 *	58	26 *	45 *
VAN	110	94	104	183

* Sample size is marginal for defining an activity pattern.

** Sample size is not adequate for defining an activity pattern.

Table 7. Sample size used to derive the daily fishing activity pattern for each survey stratum, 1999.

	May	Jun	July	Aug
Weekdays				
CAM	20 *	121	169	169
COC	1 **	19 *	41 *	14 *
QUL	29	68	92	146
NAN	76	282	141	148
SAN	0 **	2 **	7 **	2 **
VIC	41	92	185	245
STU	0	3 **	9 **	11 **
SECH	10 **	110	100	80
VAN	16 *	39 *	31 *	48 *
Weekend Days				
CAM	63	105	326	263
COC	11 **	32 *	30 *	15 *
QUL	55	91	171	203
NAN	140	207	351	270
SAN	6 **	8 **	22 *	19 *
VIC	127	95	328	361
STU	0 **	4 **	10 **	12 **
SECH	86	91	146	53
VAN	71	55	113	105

* Sample size is marginal for defining an activity pattern.

** Sample size is not adequate for defining an activity pattern.

Table 8. Recommended times for conducting aerial survey boat counts in each of the Georgia Strait Creel Survey regions by month and day type based on analysis of the 1998 activity pattern data.

Weekdays	May	June	July	August	September
Vancouver	0900-0940	0800-0840	0900-0940	0700-0740	0900-0940
Victoria	0940-1040	0840-0940	0940-1040	0740-0840	0940-1040
Saanich	1040-1045	0940-0945	1040-1045	0840-0845	1040-1045
Nanaimo	1045-1125	0945-1025	1045-1125	0845-0925	1045-1125
Qualicum	1125-1145	1025-1045	1125-1145	0925-0945	1125-1145
Comox	1145-1205	1045-1105	1145-1205	0945-1005	1145-1205
Campbell River	1205-1240	1105-1140	1205-1240	1005-1040	1205-1240
Stuart Island	1240-1300	1140-1200	1240-1300	1040-1100	1240-1300
Sechelt	1300-1450	1200-1350	1300-1450	1100-1250	1300-1450
Weekends					
Vancouver	0900-0940	0800-0840	0700-0740	0900-0940	1000-1040
Victoria	0940-1040	0840-0940	0740-0840	0940-1040	1040-1140
Saanich	1040-1045	0940-0945	0840-0845	1040-1045	1140-1145
Nanaimo	1045-1125	0945-1025	0845-0925	1045-1125	1145-1225
Qualicum	1125-1145	1025-1045	0925-0945	1125-1145	1225-1245
Comox	1145-1205	1045-1105	0945-1005	1145-1205	1245-1305
Campbell River	1205-1240	1105-1140	1005-1040	1205-1240	1305-1340
Stuart Island	1240-1300	1140-1200	1040-1100	1240-1300	1340-1400
Sechelt	1300-1450	1200-1350	1100-1250	1300-1450	1400-1550

Table 9. Three levels of CPE groupings used to estimate catch for each sub-area.

Sub-area	Sub-Area Groupings				Sub-area	Sub-Area Groupings			
	Level 1	Level 2	Level 3			Level 1	Level 2	Level 3	
13a	13a	13a,b,d,g-k	13a-k		17a	17a	17a,b,c	17a-e	
13b	13b	13a,b,d,g-k	13a-k		17b	17b	17a,b,c	17a-e	
13c	13c	13c,e,f	13a-k		17c	17c	17a,b,c	17a-e	
13d	13d	13a,b,d,g-k	13a-k		17d	17d	17d,e	17a-e	
13e	13e	13c,e,f	13a-k		17e	17e	17d,e	17a-e	
13f	13f	13c,e,f	13a-k		17f	17f	14a,b,17f	14a,b,17f	*
13g	13g	13a,b,d,g-k	13a-k		17g	17g	16a,b,c,17g,29c	16a,b,c,f,j,17g,29c	
13h	13h	13a,b,d,g-k	13a-k						
13i	13i	13a,b,d,g-k	13a-k		18a	18a	18a,19a	18a-d,19a,b,c	
13j	13j	13a,b,d,g-k	13a-k		18b	18b	18b,19b	18a-d,19a,b,c	
13k	13k	13a,b,d,g-k	13a-k		18c	18c	18c,d	18a-d,19a,b,c	
					18d	18d	18c,d	18a-d,19a,b,c	
14a	14a	14a,b,17f	14a,b,17f	*					
14b	14b	14a,b,17f	14a,b,17f	*	19a	19a	18a,19a	18a-d,19a,b,c	
14c	14c	14c,d	14c,d,e,f		19b	19b	18b,19b	18a-d,19a,b,c	
14d	14d	14c,d	14c,d,e,f		19c	19c	19c,d	18a-d,19a,b,c	
14e	14e	14e,f	14c,d,e,f		19d	19d	19c,d	18a-d,19a,b,c	
14f	14f	14e,f	14c,d,e,f		19e	19e	19e,f	19e,f	*
14g	14g	14g,h,16d,e	14g,h,16d,e	*	19f	19f	19e,f	19e,f	*
14h	14h	14g,h,16d,e	14g,h,16d,e	*					
14i	14i	14i,j,k	14i,j,k	*	28a	28a	28a,d,e	28a-e	
14j	14j	14i,j,k	14i,j,k	*	28b	28b	28b,c	28a-e	
14k	14k	14i,j,k	14i,j,k	*	28c	28c	28b,c	28a-e	
					28d	28d	28a,d,e	28a-e	
15a	15a	15a,16i	15a-d,16g,h,i		28e	28e	28a,d,e	28a-e	
15b	15b	15b,c,d	15a-d,16g,h,i						
15c	15c	15b,c,d	15a-d,16g,h,i		29a	29a	28a,d,e	28a-e	
15d	15d	15b,c,d	15a-d,16g,h,i		29b	29b	28a,d,e	28a-e	
					29c	29c	16a,b,c,17g,29c	16a,b,c,f,j,17g,29c	
16a	16a	16a,b,c,17g,29c	16a,b,c,f,j,17g,29c		29d	29d	29d	29d	*
16b	16b	16a,b,c,17g,29c	16a,b,c,f,j,17g,29c						
16c	16c	16a,b,c,17g,29c	16a,b,c,f,j,17g,29c						
16d	16d	14g,h,16d,e	14g,h,16d,e	*					
16e	16e	14g,h,16d,e	14g,h,16d,e	*					
16f	16f	16f,j	16a,b,c,f,j,17g,29c						
16g	16g	16g,h	15a-d,16g,h,i						
16h	16h	16g,h	15a-d,16g,h,i						
16i	16i	15a,16i	15a-d,16g,h,i						
16j	16j	16f,j	16a,b,c,f,j,17g,29c						

* indicates those sub-areas where the groupings do not change between Level 2 and Level 3.

FIGURES

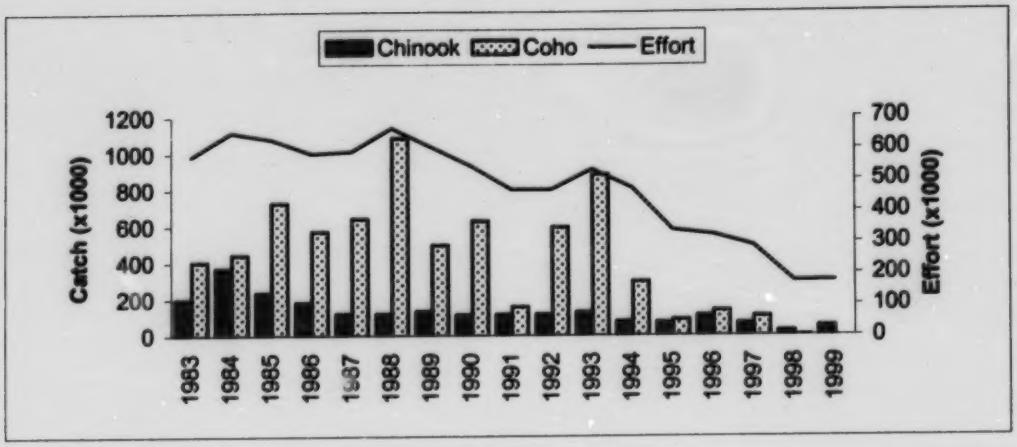


Figure 1. Annual fishing effort and catch estimates for chinook and coho salmon for the Strait of Georgia recreational fishery 1983-1999 (source: Table 1).

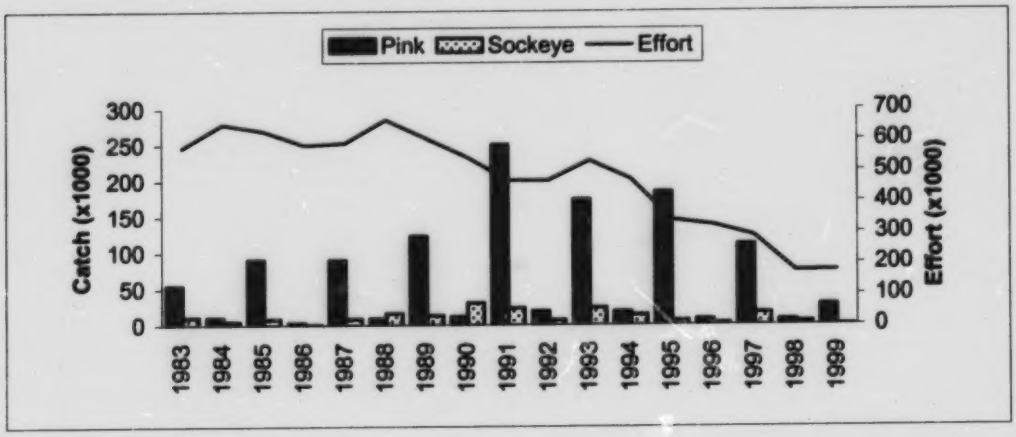


Figure 2. Annual fishing effort and catch estimates for pink and sockeye salmon for the Strait of Georgia recreational fishery 1983-1999 (source: Table 1).

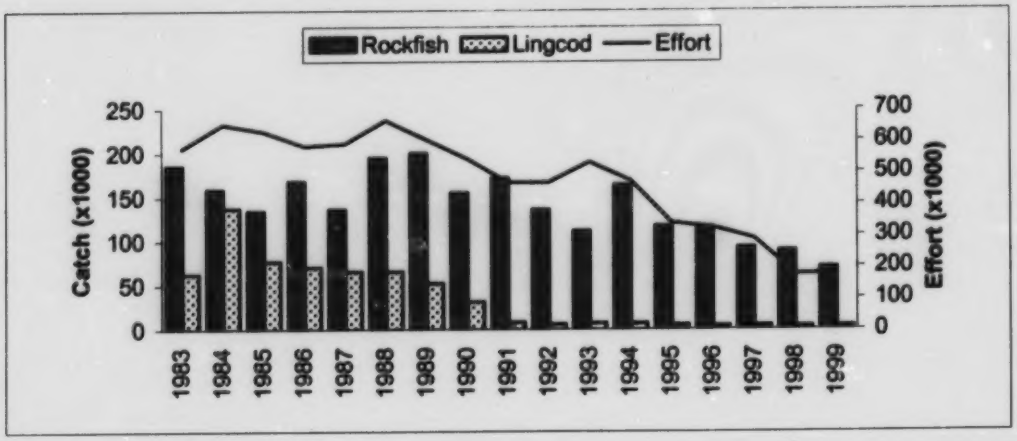


Figure 3. Annual fishing effort and catch estimates for rockfish and lingcod for the Strait of Georgia recreational fishery 1983-1999 (source: Table 1).

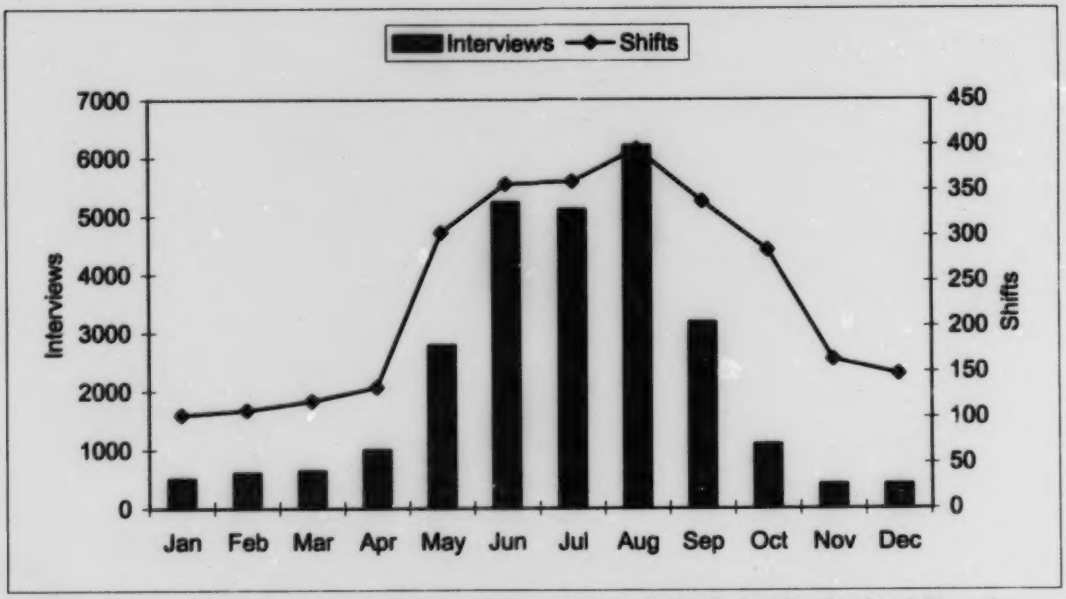


Figure 4. Monthly distribution of interviews and survey shifts for the Strait of Georgia creel survey in 1988.

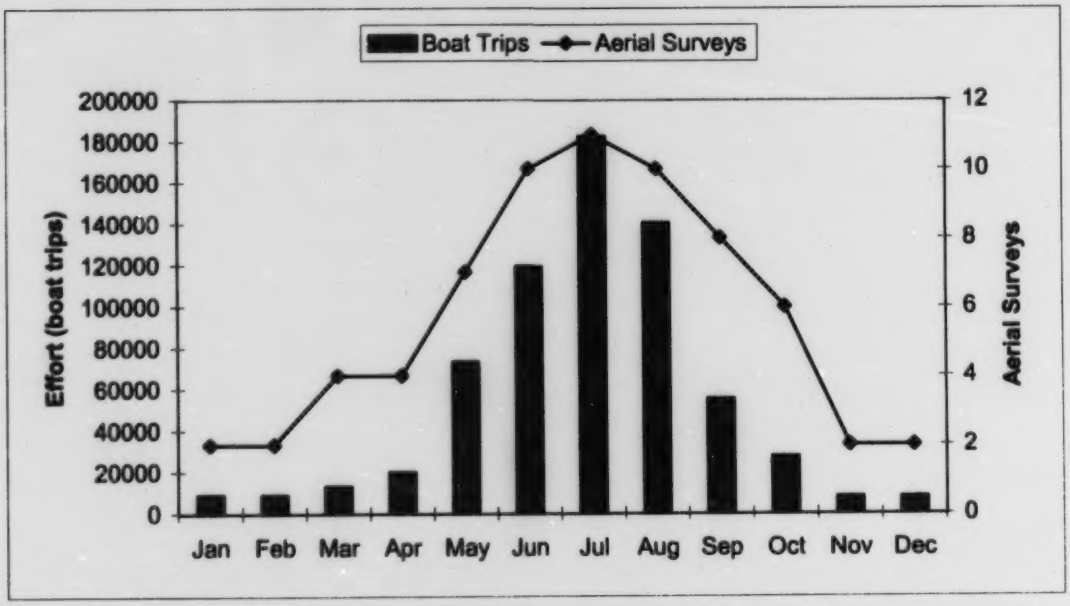


Figure 5. Monthly distribution of fishing effort and aerial surveys for the Strait of Georgia creel survey in 1988.

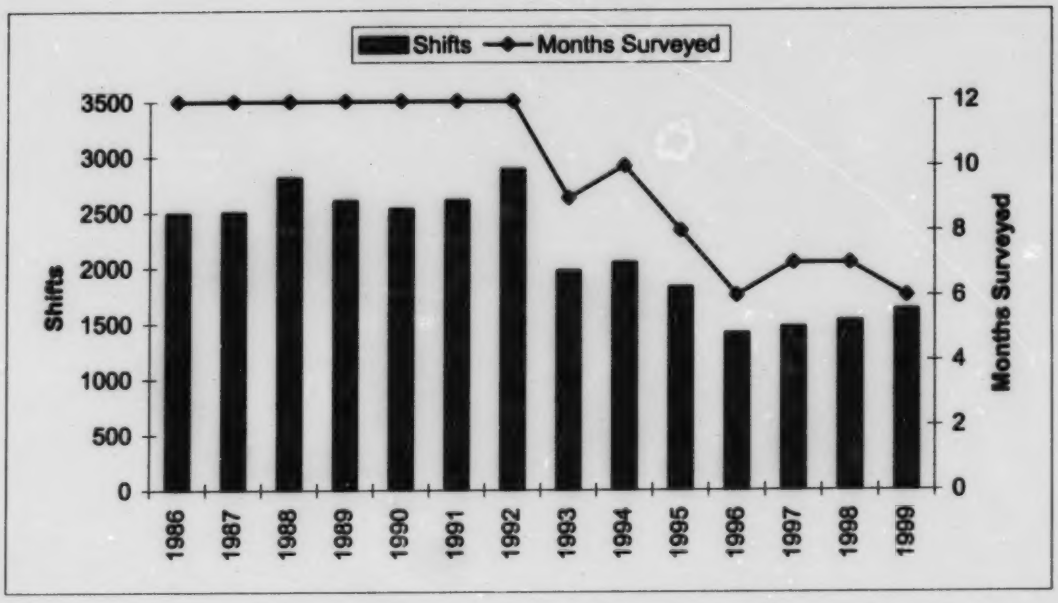


Figure 6. Annual interview survey effort expressed in term of the number of interview shifts and months surveyed each year from 1986-99.

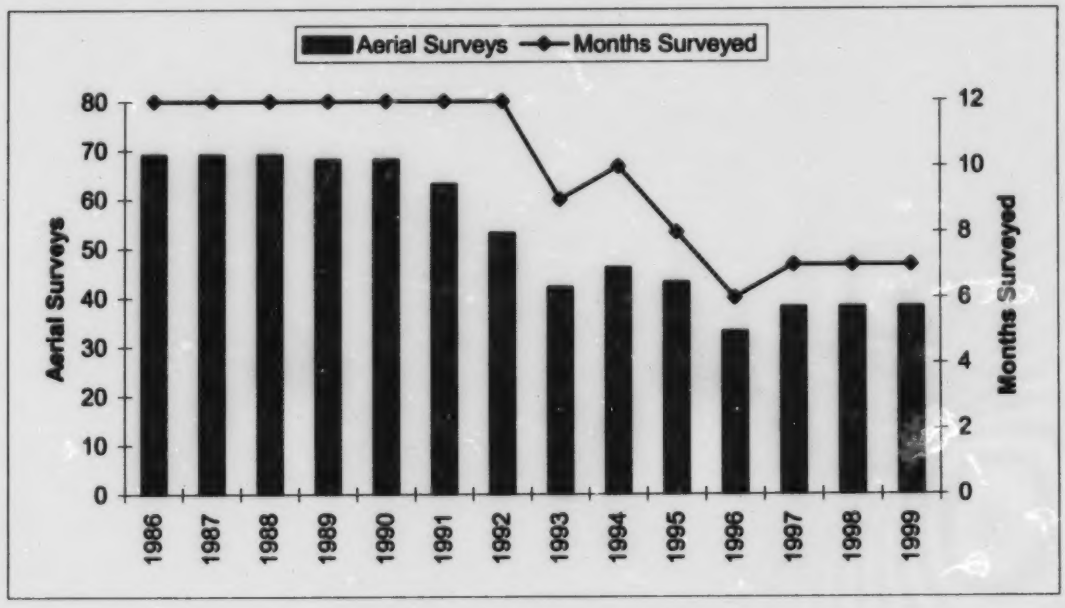


Figure 7. Annual aerial survey effort expressed in term of the number of aerial surveys of the entire fishing area and months surveyed each year from 1986-99.

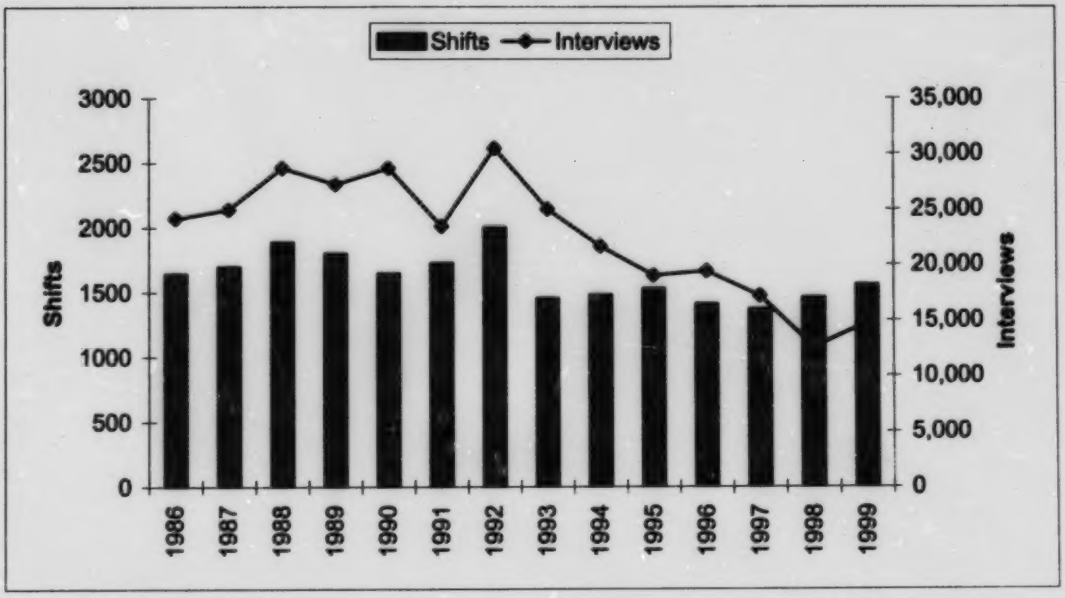


Figure 8. Surveyor shifts and angler interviews during the April-September period when creel surveys were conducted each year from 1986-1999.

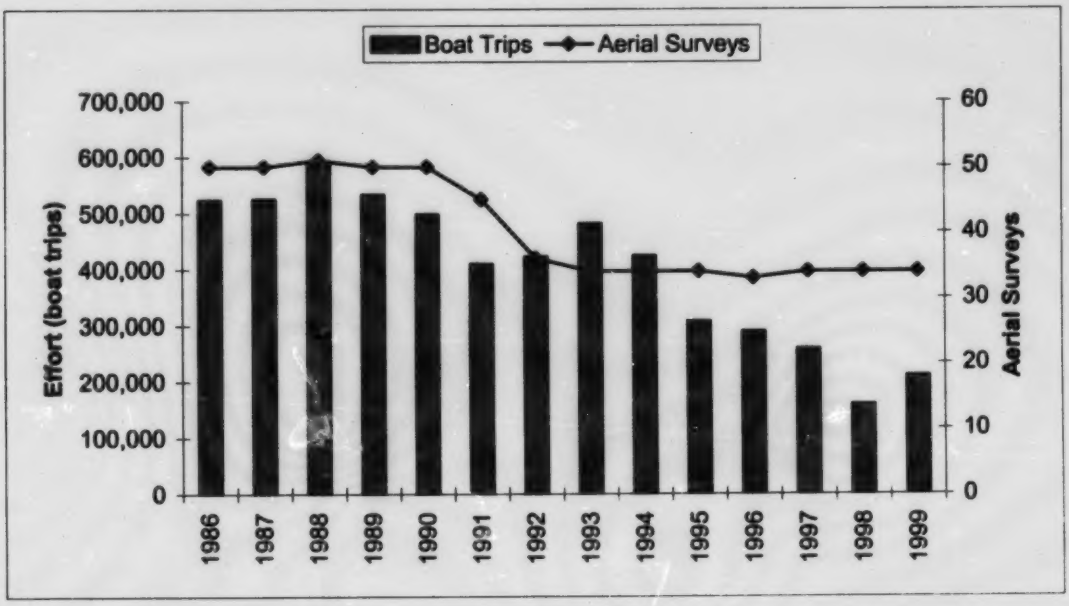


Figure 9. Angler effort and the number of aerial surveys during the April-September period when creel surveys were conducted each year from 1986-1999.

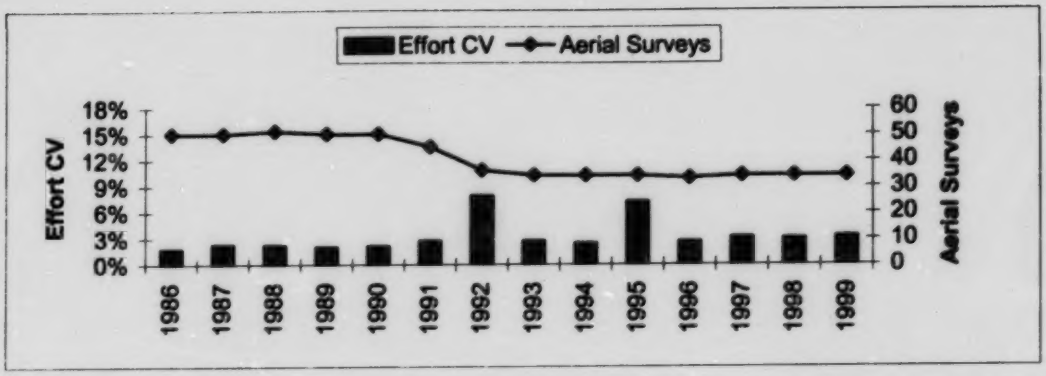


Figure 10. Aerial survey effort and the precision of the April-September effort estimate, expressed using the coefficient of variation (CV), 1986-1999.

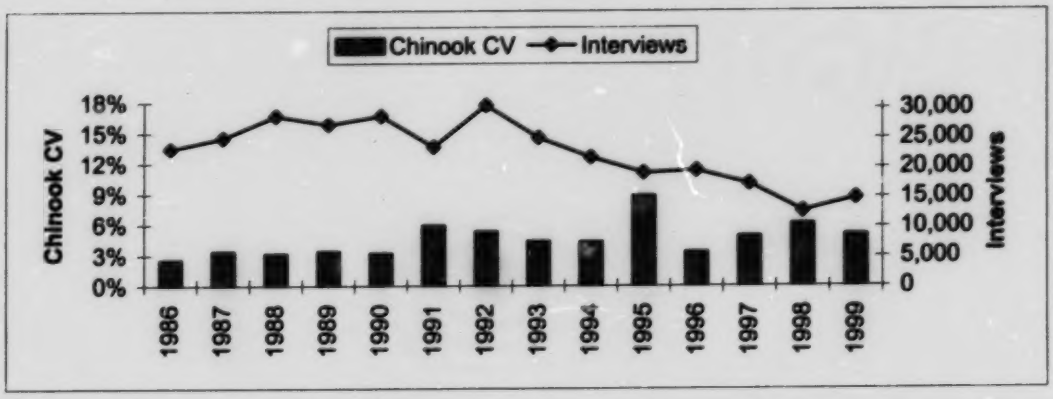


Figure 11. Interview effort and the precision of the April-September chinook catch estimate, expressed using the coefficient of variation (CV), 1986-1999.

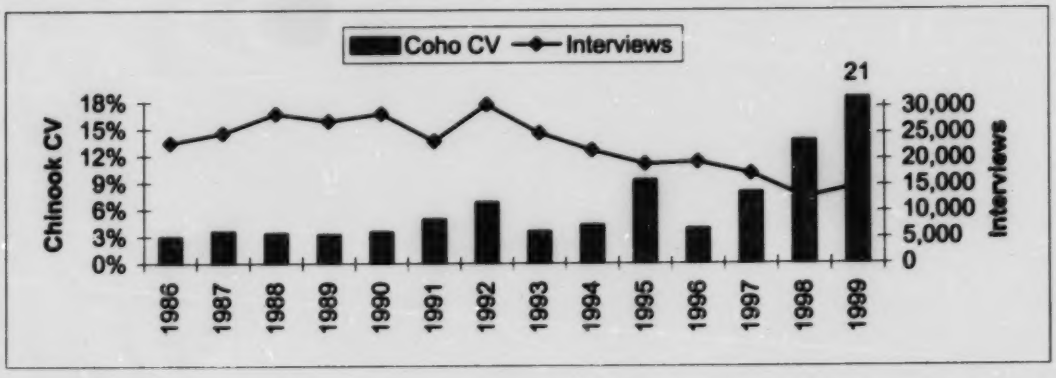


Figure 12. Interview effort and the precision of the April-September coho catch estimate, expressed using the coefficient of variation (CV), 1986-1999.

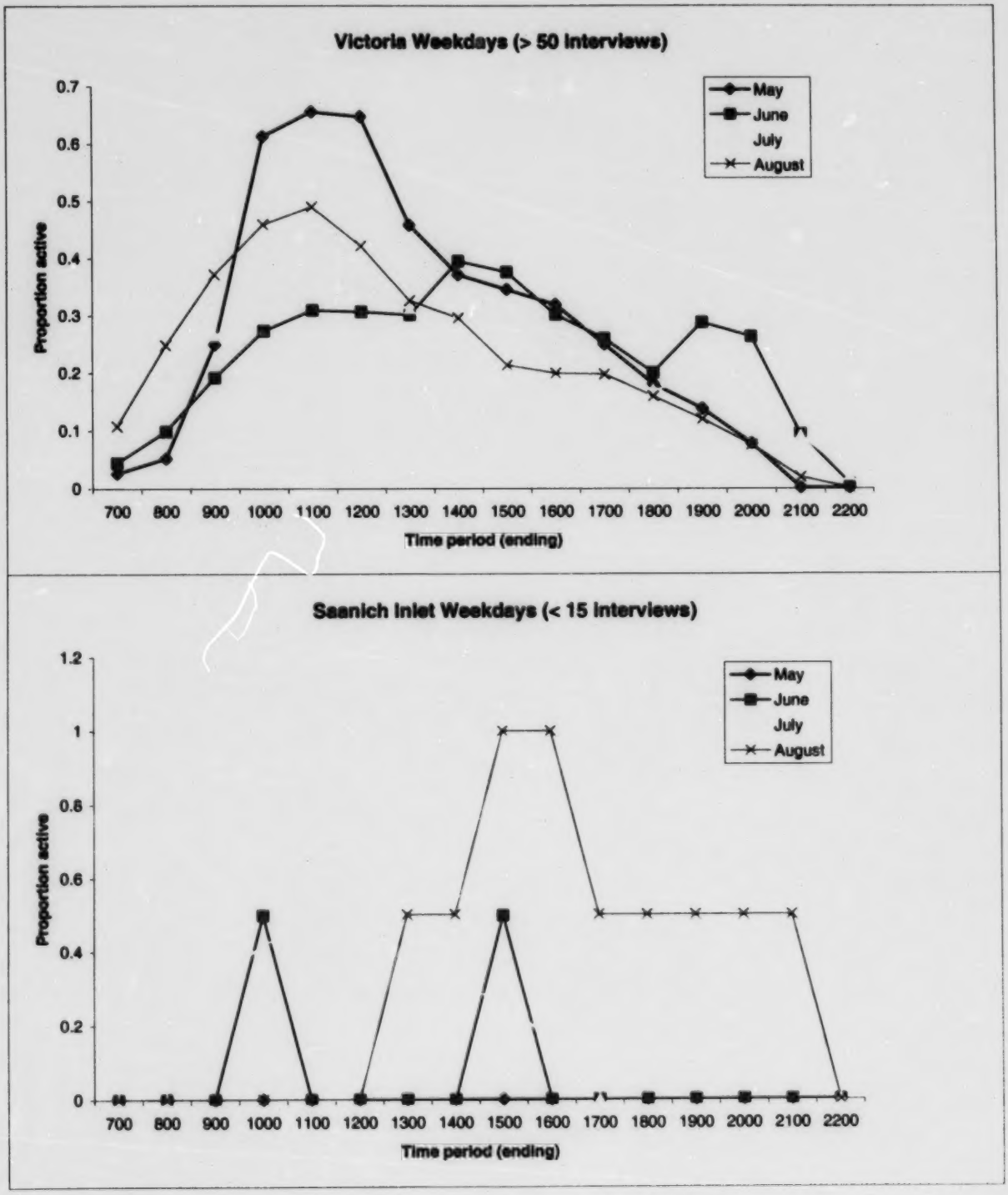


Figure 13. Sport fishing activity patterns for Victoria and Saanich Inlet, May - August, 1999.

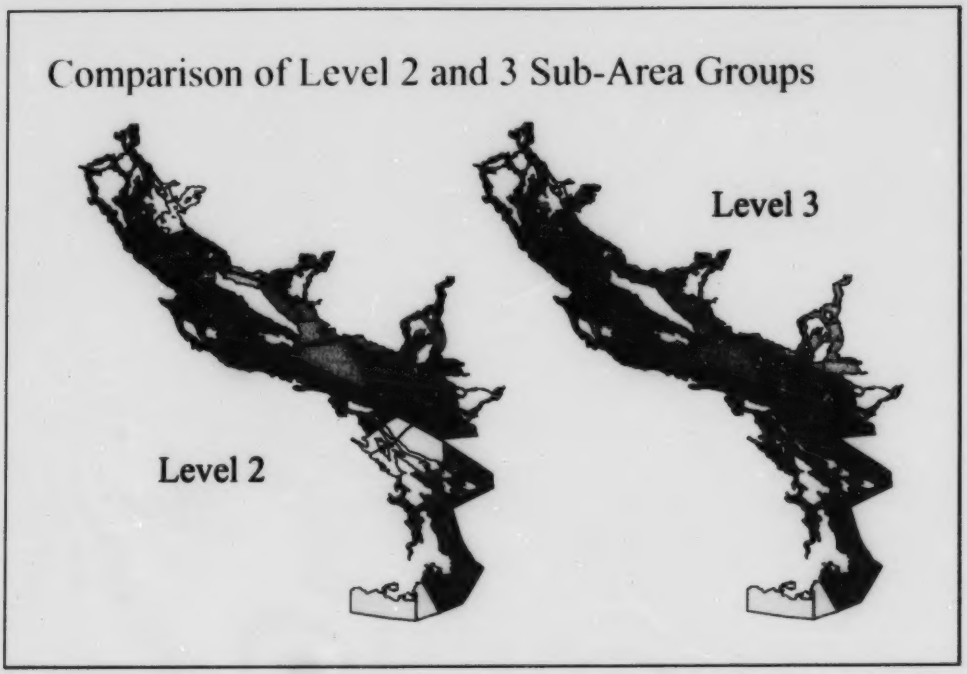


Figure 14. Comparison of the spatial resolution for Level 2 and Level 3 sub-area groups, where CPE is estimated by combining all the data from sub-areas with the same colour to estimate catch for the component sub-

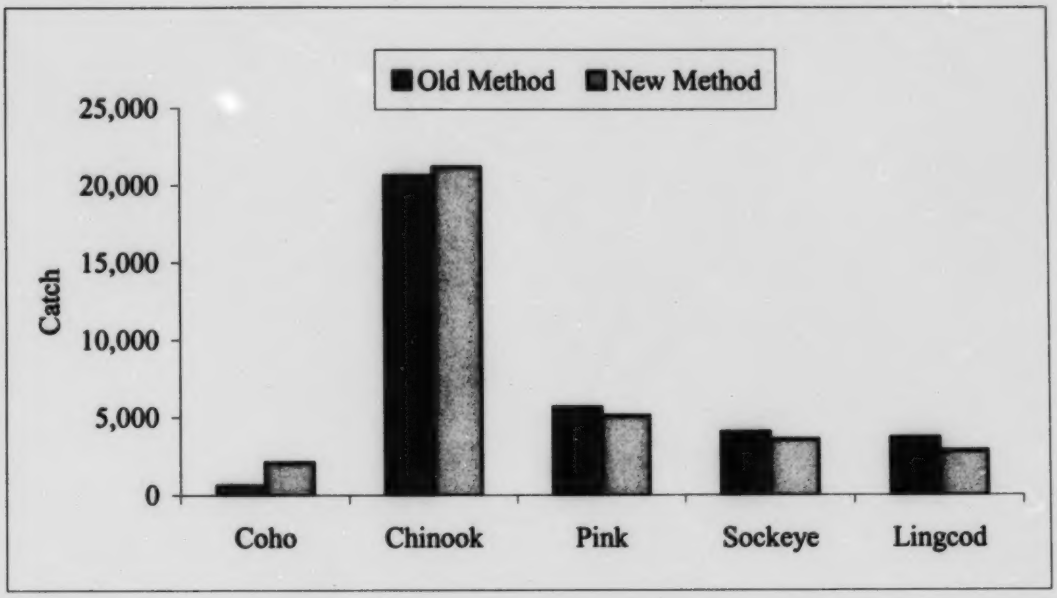


Figure 15. Comparison of the catch estimates for the 1998 Strait of Georgia recreational fishery derived using the "old" and "new" estimation procedures.

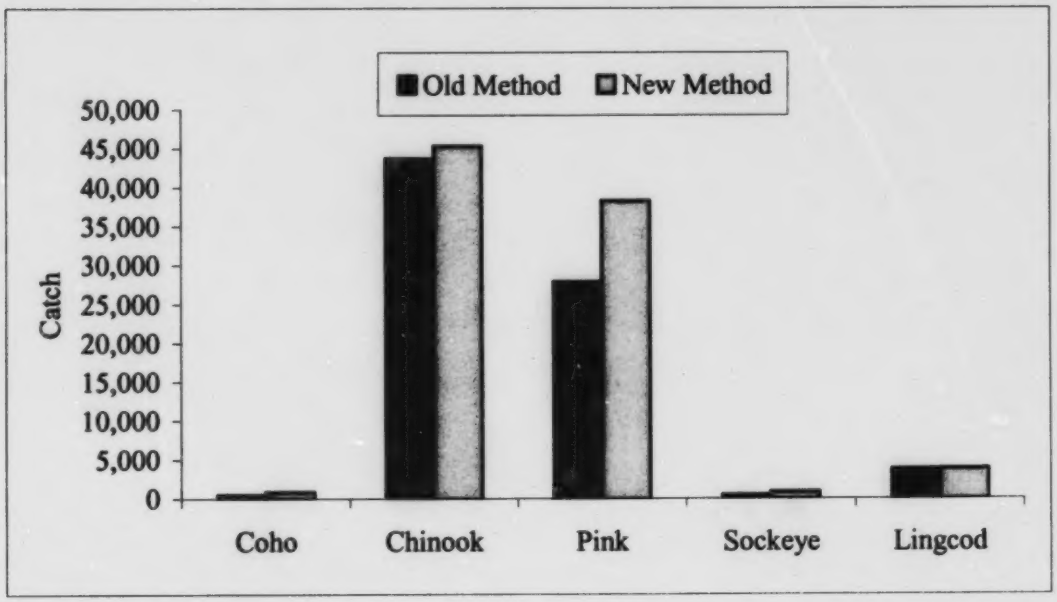


Figure 16. Comparison of the catch estimates for the 1999 Strait of Georgia recreational fishery derived using the "old" and "new" estimation procedures.

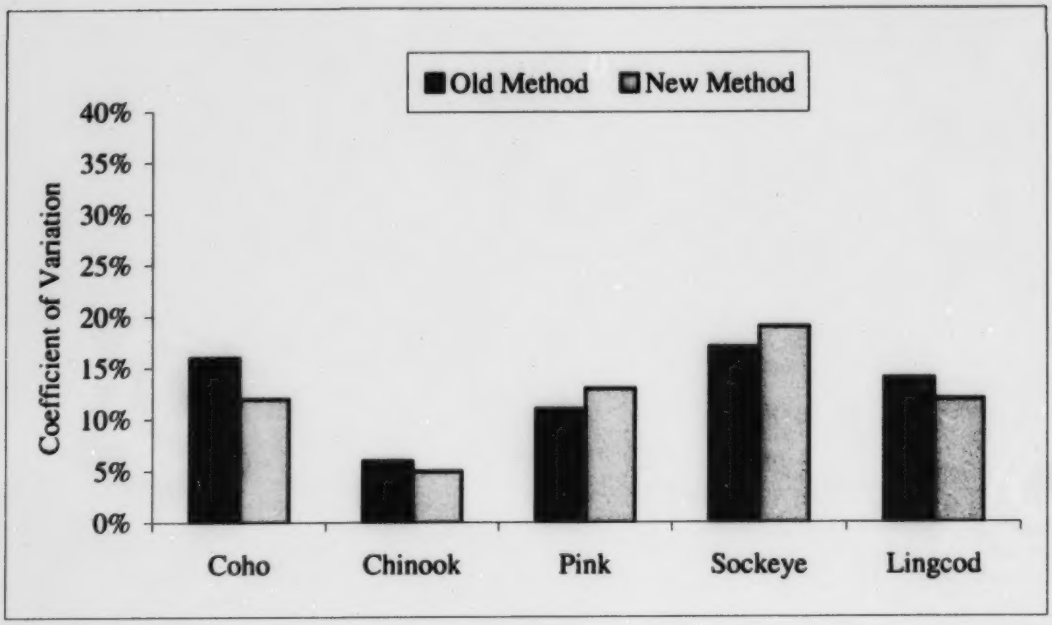


Figure 17. recreational fishery catch estimates derived using the "old" and "new" estimation procedures.

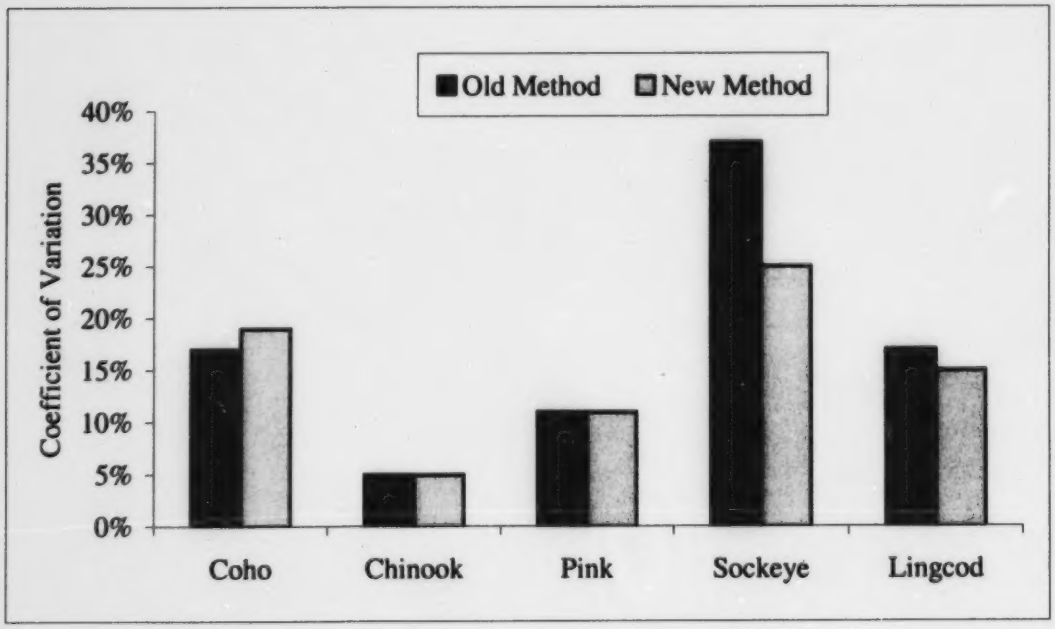
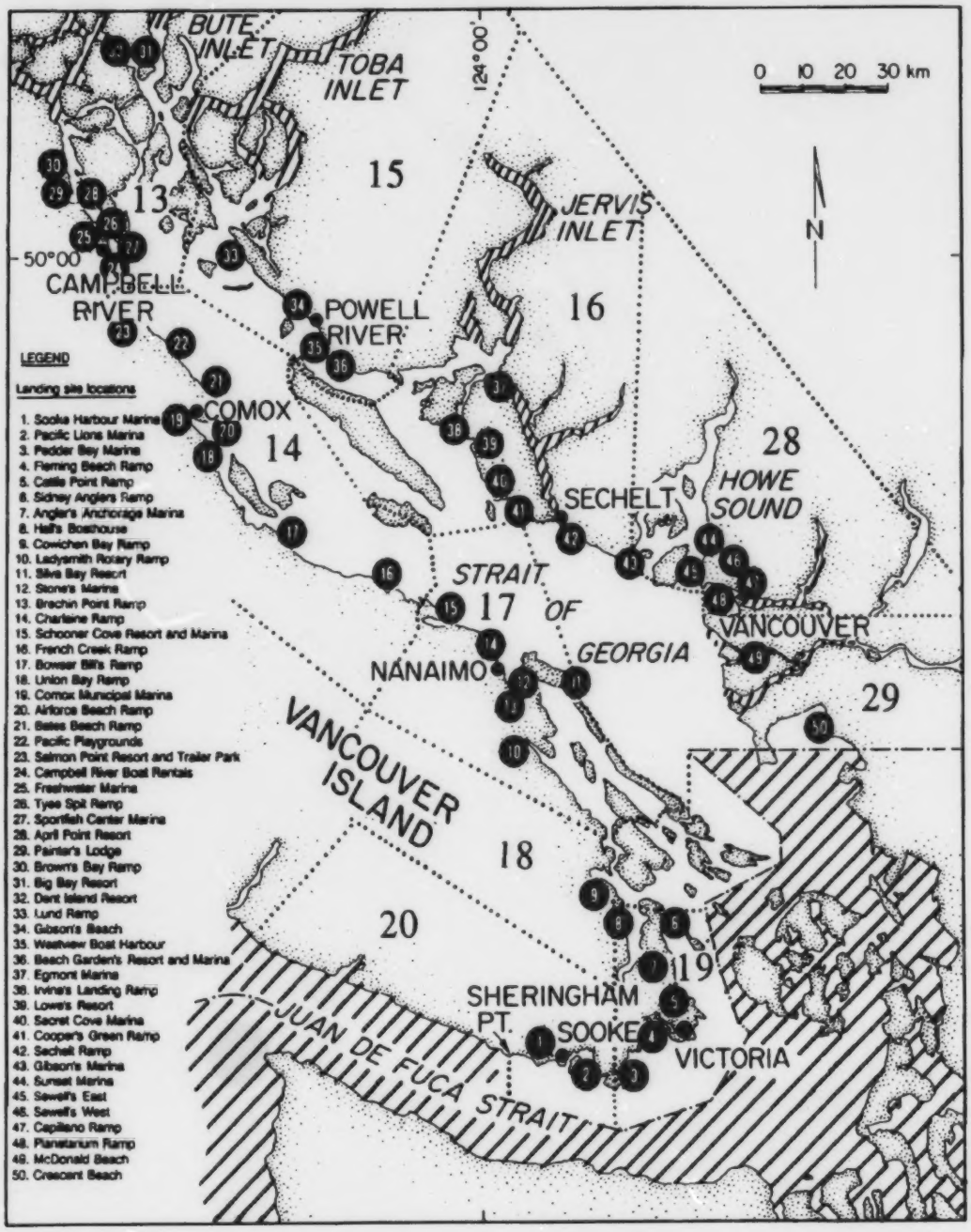


Figure 18. recreational fishery catch estimates derived using the "old" and "new" estimation procedures.

APPENDICES

APPENDIX A. Strait of Georgia Creel Survey Study Area and Landing Site Locations, 1998.



APPENDIX B1. METHODS AND EQUATIONS USED IN ANALYSIS OF CATCH AND EFFORT STATISTICS FOR THE STRAIT OF GEORGIA SPORT FISHERY CREEL SURVEY 1983-99.

The description of terms, variables and subscripts used in the data analysis is given in Appendix Table B1.

Calculation of Catch and Effort Statistics

To estimate the monthly catch and effort, three components had to be calculated from a month's data:

(1) the weighted mean daily fishing pattern from interview data,
(2) the weighted mean catch per effort from interview data and
(3) the mean sport count from overflight data.

The equations used to estimate the means and variances for all catch and effort statistics are shown below.

Weighting factors used to estimate the daily fishing activity pattern were calculated using the equations derived from DPA Consulting Ltd. (1982). The data obtained from each shift were multiplied by the following weighting factor (*W1*) to expand for all possible stints at each site. The formula reads:

$$W1_{dij} = \frac{N_d}{n_{dij}} \qquad (1)$$

where N_d is the total number of type d days in that month and n_{dij} is the number of times that work block j was sampled at site i on type d days.

The interviews aggregated by work block were multiplied by the weighting factor *W2* to expand for all boats that landed in each work block. The formula reads:

$$W2_{dijk} = \frac{L_{dijk}}{I_{dijk}} \qquad (2)$$

where L_{dijk} is the number of boats landed and I_{dijk} is the number of boats interviewed during stint k in work block j at site i on type d days.

Appendix Table B1. Description of terms, variables and subscripts used in this report.

DESCRIPTION OF TERMS

Shift/Stint Represents a combination of a day type and landing site which was sampled on a single day (i.e. one sampling stint performed by an interviewer).

Work block Represents one of four possible periods at a particular site of a given day type.

Work Block 1 is before 11 am
Work Block 2 is 11 am - 3 pm
Work Block 3 is 3 pm - 7 pm
Work Block 4 is after 7 pm

Day type There are two day types: weekdays and weekends; holidays are classified as weekend days.

Time block - Each day is divided into 16 time blocks which are:

1) before 7 am
2) 7:00 - 7:59 am
3) 8:00 - 8:59 am
.
.
15) 8:00 - 8:59 pm
16) after 9 pm

DESCRIPTION OF VARIABLES

A	-	Number of boats actively fishing
B	-	Number of boats observed on a flight
C	-	Catch
C'	-	Catch of marked salmon
CPE	-	Catch per boat trip
E	-	Effort (estimated total number of boat trips)
I	-	Number of boats interviewed and found to have been fishing
L	-	Number of boats landing
n	-	Number sampled
N	-	Population size from which n samples were observed
P	-	Proportion
T	-	Number of boat trips
V	-	Number found to be marked
W1	-	Weighting factor to expand for all possible stints at each site
W2	-	Weighting factor to expand for all boats that landed in each work

DESCRIPTION OF SUBSCRIPTS

a	-	age
g	-	a set of landing sites
d	-	day type
i	-	site
j	-	work block
k	-	stint
l	-	landing time block
m	-	month
q	-	fishing party interviewed
r	-	species
s	-	sub-Statistical Area
t	-	time block
u	-	flight
x	-	region
y	-	annual

Therefore, the following equations can be used to calculate an unbiased estimate of the total monthly catch ($\hat{C}_{dgr}$), fishing trips ($\hat{T}_{dg}$) and fishing activity in time block $\hat{A}_{dgt}$ for each day type (d) where g is a set of landing sites (i). These formulas read:

$$\hat{C}_{dgr} = \sum_i \sum_j \left[W1_{dij} \sum_k \sum_q (W2_{dijk} C_{dijklqr}) \right] \tag{3}$$

$$\hat{T}_{dg} = \sum_i \sum_j \left[W1_{dij} \sum_k \sum_q (W2_{dijk}) \right] \tag{4}$$

$$\hat{A}_{dgt} = \sum_i \sum_j \left[W1_{dij} \sum_k \sum_q (W2_{dijk} A_{dijkqt}) \right] \tag{5}$$

where C_{dijkqr} is the catch of species r by the qth fishing party, and A_{dijkqt} can equal 0 or 1, thereby indicating whether the qth fishing party was actively fishing in time block t. Thus, the mean monthly catch per unit effort (CPE_{dgr}) measured in terms of numbers of fish kept per completed boat trip, and proportion of daily fishing effort active during the hour of the aerial survey (P_{dgt}) can be calculated with the following equations:

$$CPE_{dgr} = \frac{\hat{C}_{dgr}}{\hat{T}_{dg}} \tag{6}$$

$$P_{dgt} = \frac{\hat{A}_{dgt}}{\hat{T}_{dg}} \tag{7}$$

where CPE_{dgr} and P_{dgt} are calculated for each day type (d) and group of landing sites (g).

The groups of landing sites reflect geographic areas with similar catch rates and/or activity patterns.

The estimated mean number of boats fishing during the hour of the sport boat count by overflight was calculated for each sub-Statistical Area using the following equation:

$$\overline{B}_{dst} = \frac{\sum_{u} B_{sdtu}}{n_{ds}} \qquad (8)$$

where B_{dstu} is the number of boats observed fishing on flight u at time t, in sub-Statistical Area s for day type d.

The mean sport boat count at the time of the overflight ($\overline{B}_{dst}$) and proportion of daily fishing effort active during the hour of the overflight (P_{dgt}) were used in the following equation to calculate the total fishing effort for sub-Statistical Area s on day type d:

$$E_{ds} = \overline{B}_{dst} \frac{1}{P_{dgt}} N_d \qquad (9)$$

where N_d is the number of type d days in the month. Interview data for the sub-Statistical Areas fished (s) by anglers landing at each of the sites (i) within a landing group (g) were used to select the proportions (P_{dgt}) that are appropriate for each mean boat count ($\overline{B}_{dst}$).

The estimate for total effort by sub-Statistical Area and day type (E_{ds}) and the weighted catch per boat trip for a group of landing sites by day type, area and species (CPE_{dgr}) were used to calculate total catch for each species (r) and each sub-Statistical Area (s):

$$C_{sr} = \sum_{d} (E_{ds} CPE_{dgr}) \qquad (10)$$

The interview data were also used to select the catch per effort estimates (CPE_{dgr}) that should be applied to the effort estimates (E_{ds}) for a specific sub-Statistical Area (s).

Variance of Total Fishing Effort

The variance for estimates of total fishing effort has two components:

(1) the variance in aerial sport boat counts:

$$S^2_{B_{dst}} = \frac{\sum_u B^2_{dstu} - \frac{\left(\sum_u B_{dstu}\right)^2}{n_{ds}}}{n_{ds}(n_{ds}-1)} \left[\frac{N_d - n_{ds}}{N_d - 1}\right] \qquad (11)$$

where B_{dstu} is the aerial sport boat count at time t during an aerial survey u on a type d day in sub-area s; n_{ds} is the number of aerial surveys in which boats were counted on type d days, in sub-Statistical Area s; and N_d is the total number of type d days in the months.

(2) the variance in the proportion of boats fishing during the hours of the aerial boat counts:

$$S^2_{P_{dgt}} = \frac{P_{dgt}(1-P_{dgt})}{I_{dg}} \qquad (12)$$

where P_{dgt} is the mean proportion of boats fishing for a group of landing sites g during the hour of the aerial boat count t on type d days, and I_{dg} is the total number of sport fishing boats interviewed. The above formula assumes P_{dgt} is unbiased and normally distributed where the number of interviews is large.

The variances for boat counts ($S^2_{B_{dst}}$) and proportion of boats fishing ($S^2_{P_{dgt}}$) were combined in the following equation to calculate variance for effort:

$$S^2_{E_{ds}} = N_d^2 \left(\frac{B^2_{dst}}{P^2_{dgt}}\right)\left(\frac{S^2_{B_{dst}}}{B^2_{dst}} + \frac{S^2_{P_{dgt}}}{P^2_{dgt}}\right) \qquad (13)$$

where $S^2_{E_{ds}}$ is the variance for total effort on type d days in sub-area s, and the formula is the standard formula for the variance of a ratio of two independent random variables.

Variance of Total Catch

The variance for estimates of total catch had two components: (1) the variance for total effort (presented above), and (2) the variance for catch per boat trip.

The variance for catch per boat trip ($S^2_{CPE_{dgr}}$) was calculated using the following equation:

$$S^2_{CPE_{dgr}} = \frac{SS_{CPE_{dgr}} - \frac{\left(S_{CPE_{dgr}}\right)^2}{I_{dg}}}{I_{dg}(I_{dg}-1)} \qquad (14)$$

where $SS_{CPE_{dgr}}$ is the weighted sum of squares for CPE_{dgr}, and $S_{CPE_{dgr}}$ is the weighted sum for CPE_{dgr}, such that the sum of the weighting factors used to estimate CPE_{dgr} was equal to the number of interviewed boat trips (I_{dg}).

The variance for total effort and the variance in the catch per boat trip for the appropriately grouped landing sites were combined in the following equation to calculate variance for total catch:

$$S^2_{C_{sr}} = \sum_d \left(E^2_{ds} S^2_{CPE_{dgr}} + CPE^2_{dgr} S^2_{E_{ds}} + S^2_{CPE_{dgr}} S^2_{E_{ds}} \right) \qquad (15)$$

which is the standard formula for the variance of the product of two independent random variables, and where $S^2_{C_{sr}}$ is the variance for total number of species r in sub-Statistical Area s.

Estimation of Marked Chinook and Coho Salmon

The incidence of marked (adipose-clipped) chinook and coho was recorded in each interview. The proportion of marks observed for each region, month and species (P_{xmr}) was calculated as:

$$P_{xmr} = \frac{V_{xmr}}{n_{xmr}} \tag{16}$$

where V is the number of marked fish observed and n is the number of fish inspected by region (x), month (m) and species (r).

The variance of each proportion was calculated as:

$$S^2_{P_{xmr}} = \frac{P_{xmr}(1 - P_{xmr})}{n_{xmr}} \tag{17}$$

Monthly catch estimates of marked salmon were calculated as:

$$C'_{xmr} = P_{xmr} C_{xmr} \tag{18}$$

where C_{xmr} is the estimated catch of species r in region x and month m.

The variance of the marked catch estimates was calculated as:

$$S^2_{C'_{xmr}} = P^2_{xmr} S^2_{C_{xmr}} + C^2_{xmr} S^2_{P_{xmr}} + S^2_{C_{xmr}} S^2_{P_{xmr}} \tag{19}$$

where $S^2_{C_{xmr}}$ is the variance of the catch estimates of species r in region x and month m.

The estimate annual proportions of marked salmon caught in each region (weighted by the corresponding regional annual catch estimates) were calculated as:

$$P_{xry} = \frac{C'_{xry}}{C_{xry}} \tag{20}$$

where

$$C'_{xry} = \sum_m C'_{xmr} \quad \text{and} \quad C_{xry} = \sum_m C_{xmr} \tag{21}$$

The variance of the annual proportions was calculated as:

$$S^2_{P_{xry}} = \left(\frac{C'_{xry}}{C_{xry}}\right)^2 \left[\frac{S^2_{C'_{xry}}}{(C'_{xry})^2} + \frac{S^2_{C_{xry}}}{(C_{xry})^2}\right] \quad (22)$$

where $S^2_{C_{xry}}$ is the variance of the annual estimated catch of species r in region x.

Estimation of Age Composition of Chinook Catch

Scale samples and length measurements were taken in a sub-sampling program during the interview process. Ages used in this report represent total age of the fish (including both freshwater and oceanic life) according to the Gilbert-Rich (1927) recording convention.

The proportion of chinook at each age and month (P_{am}) was calculated as:

$$P_{am} = \frac{a_m}{n_m} \quad (23)$$

where a_m represents the number of fish observed at age a during month m, and n_m is the total number of fish bio-sampled in that month.

The variance of each proportion was calculated as:

$$S^2_{am} = \frac{P_{am}(1 - P_{am})}{n_m} \quad (24)$$

The catch at age of chinook in each month was calculated as:

$$C_{am} = P_{am} C_m \quad (25)$$

where C_m is the estimated catch of chinook salmon in a given month m.

The variance of the catch at age estimate was calculated as:

$$S^2_{C_{am}} = P^2_{am} S^2_{C_m} + C^2_m S^2_{P_{am}} + S^2_{C_m} S^2_{P_{am}} \qquad (26)$$

where $S^2_{C_m}$ is the variance of the month catch estimate C_m.

The annual catch at age was calculated as:

$$C_{ay} = \sum_m C_{am} \qquad (27)$$

with a variance:

$$S^2_{C_{ay}} = \sum_m S^2_{C_{am}} \qquad (28)$$

The annual proportion at age (weighted by monthly catch) was calculated as:

$$P_{ay} = \frac{C_{ay}}{C_y} \qquad (29)$$

with a variance:

$$S^2_{P_{ay}} = \left(\frac{C_{ay}}{C_y} \right)^2 \left[\frac{S^2_{C_{ay}}}{(C_{ay})^2} + \frac{S^2_{C_y}}{(C_y)^2} \right] \qquad (30)$$

APPENDIX B2. REVISED METHODS AND EQUATIONS CURRENTLY USED IN ANALYSIS OF CATCH AND EFFORT STATISTICS FOR THE STRAIT OF GEORGIA SPORT FISHERY CREEL SURVEY.

The description of terms, variables and subscripts used in these data analysis is given in Appendix Table B1.

Calculation of Catch and Effort Statistics

To estimate the monthly catch and effort, three components had to be calculated from a month's data:

(1) the weighted mean daily fishing pattern from interview data,
(2) the mean catch per effort from interview data and
(3) the mean daily sport effort from overflight data.

The equations used to estimate the means and variances for all catch and effort statistics are shown below.

Weighting factors used to estimate the daily fishing activity pattern were calculated using the equations derived from DPA Consulting Ltd. (1982). The data obtained from each shift were multiplied by the following weighting factor (*W1*) to expand for all possible stints at each site. The formula reads:

$$W1_{dij} = \frac{N_d}{n_{dij}} \tag{1}$$

where N_d is the total number of type d days in that month and n_{dij} is the number of times that work block j was sampled at site i on type d days.

The interviews aggregated by work block were multiplied by the weighting factor *W2* to expand for all boats that landed in each work block. The formula reads:

$$W2_{dijk} = \frac{L_{dijk}}{I_{dijk}} \tag{2}$$

where L_{dijk} is the number of boats landed and I_{dijk} is the number of boats interviewed during stint k in work block j at site i on type d days.

When catch per effort (*CPE*) was estimated for each group of landing sites, the above weighting factors were used to adjust the catch and effort estimates for disproportional sampling of boat trips and landing sites. These weighting factor are no longer used to adjust the catch per

effort estimates because the current *CPE* estimates are derived separately for each sub-Statistical Area. The current estimation procedure sums the interview data for each sub-area to calculate the total observed catch (C_{cdsr}) and fishing trips (T_{cdsr}) for spatial category (c), for each day type (d), for each sub-area (s) for species (r):

$$C_{cdsr} = \sum_{s}\sum_{q} C_{dsqr} \tag{3}$$

$$T_{cds} = \sum_{s}\sum_{q} T_{dsq} \tag{4}$$

where C_{dsqr} is the catch of a species (r) and T_{dsq} is the effort, in boat trips, by a specific fishing party (q), from a sub-area (s), for each day type (d). Thus, the mean monthly catch per unit effort (CPE_{cdsr}) measured in terms of numbers of fish caught per completed boat trip was calculated using:

$$CPE_{cdsr} = \frac{C_{cdsr}}{T_{cds}} \tag{5}$$

The weighting factors described above are still used to adjust the daily fishing activity for disproportional sampling both within and between work blocks. As in the previous analyses of Strait of Georgia creel survey data (DPA 1982, English et al. 1986, Shardlow et al. 1989, Hardie et al. 1999), we derive an estimate of the total monthly fishing trips ($\hat{T}_{dg}$) and fishing activity in time block $\hat{A}_{dgt}$ for each day type (d) and group (g) of landing sites (i) using:

$$\hat{T}_{dg} = \sum_{i}\sum_{j}\left[W1_{dij}\sum_{k}\sum_{q}(W2_{dijk})\right] \tag{6}$$

$$\hat{A}_{dgt} = \sum_{i}\sum_{j}\left[W1_{dij}\sum_{k}\sum_{q}(W2_{dijk}A_{dijkqt})\right] \tag{7}$$

where A_{dijkqt} can equal 0 or 1, thereby indicating whether a specific fishing party (q) was actively fishing in each time block (t). Thus, the proportion of daily fishing effort active during the hour of the aerial survey (P_{dgt}) can be calculated with the following equation:

$$P_{dgt} = \frac{\hat{A}_{dgt}}{\hat{T}_{dg}} \tag{8}$$

where each group of landing sites (g) represents a geographic area with similar activity patterns.

The estimated number of boats fishing in each sub-area on the day of the overflight was calculated using:

$$B_{dsu} = \frac{B_{dsut}}{P_{dgt}} \tag{9}$$

where B_{dsut} is the number of sport fishing vessels observed actively fishing at time t on survey u in sub-area s on day type d and P_{dgt} is the portion of the daily fishing effort active at time t derived from the activity pattern for the group of landing sites (g) associated with that sub-area. The total monthly fishing effort E_{ds} for a specific day type (d) and sub-Statistical Area (s) was:

$$E_{ds} = \frac{\sum_{u} B_{sdu}}{n_{ds}} N_d \tag{10}$$

where n_{ds} is the number of type d days when sub-area s could be surveyed and N_d is the number of type d days in the survey month.

The total effort and catch per boat trip for each specific sub-area and day type were combined in the following equation to calculate total catch for each species (r) in each sub-area (s):

$$C_{sr} = \sum_{d} (E_{ds} CPE_{cdsr}) \tag{11}$$

The *CPE* estimates in the above equation could be derived from data for a specific sub-area or group of adjacent sub-areas depending on the interview data available for each sub-area. If there were more than five interviews that reported fishing in a specific sub-area, for a single day type, we computed a category 1 *CPE* estimates (CPE_{1dsr}) and used this value to estimate catch for that sub-area. Category 2 *CPE* estimates (CPE_{2dsr}), derived from a minimum of five interview samples from adjacent sub-areas, were used in the above equation when the available data was not adequate to calculate a Category 1 estimate. Category 3 *CPE* estimates (CPE_{3dsr}), derived from a minimum of five interview samples from several Category 2 groups of adjacent sub-areas, were used in the above equation when the available data was not adequate to calculate a Category 1 or 2 estimate.

Variance of Total Fishing Effort

The variance for estimates of total fishing effort was calculated using the following two equations:

$$S^2_{B_{ds}} = \frac{\sum_u B^2_{dsu} - \frac{\left(\sum_u B_{dsu}\right)^2}{n_{ds}}}{(n_{ds}-1)} \left[\frac{N_d - n_{ds}}{N_d - 1}\right] \qquad (12)$$

where $S^2_{B_{ds}}$ is the variance for the daily fishing effort estimate for sub-area s on day type d and all variables are as defined above, and

$$S^2_{E_{ds}} = N^2_d \; S^2_{B_{dsu}} \qquad (13)$$

where $S^2{}_{E_{ds}}$ is the variance for total effort estimate for sub-area s on day type d.

Variance of Catch per Effort

The variance for catch per boat trip ($S^2_{CPE_{cdsr}}$) was calculated using the following equation:

$$S^2 CPE_{cdsr} = \frac{SS_{CPE_{cdsr}} - \frac{\left(S_{CPEcdsr}\right)^2}{T_{cds}}}{(T_{cds}-1)} \qquad (14)$$

where $SS_{CPE_{cdsr}}$ is the sum of squares of the CPE values for each interview sample (CPE_{cdsrq}) used to compute the mean catch per boat trip (CPE_{cdsr}) for spatial category c, on day type d, from sub-area s for species r; $S_{CPE_{cdsr}}$ is the sum of these CPE_{cdsrq} values and T_{cds} is the number of interviews of completed boat trips where fishing was conducted in spatial category c on day type d.

Standard Error of the Catch Estimates

The standard error for the catch estimates for each species and sub-area was derived using the following equation:

$$SE_{C_{sr}} = \sqrt{\sum_{d}\left(E_{ds}^{2}\frac{S_{CPE_{cdsr}}^{2}}{T_{cds}} + CPE_{cdsr}^{2}\frac{S_{E_{ds}}^{2}}{n_{ds}} + \frac{S_{CPE_{cdsr}}^{2}}{T_{cds}}\frac{S_{E_{ds}}^{2}}{n_{ds}} \right)} \quad (15)$$

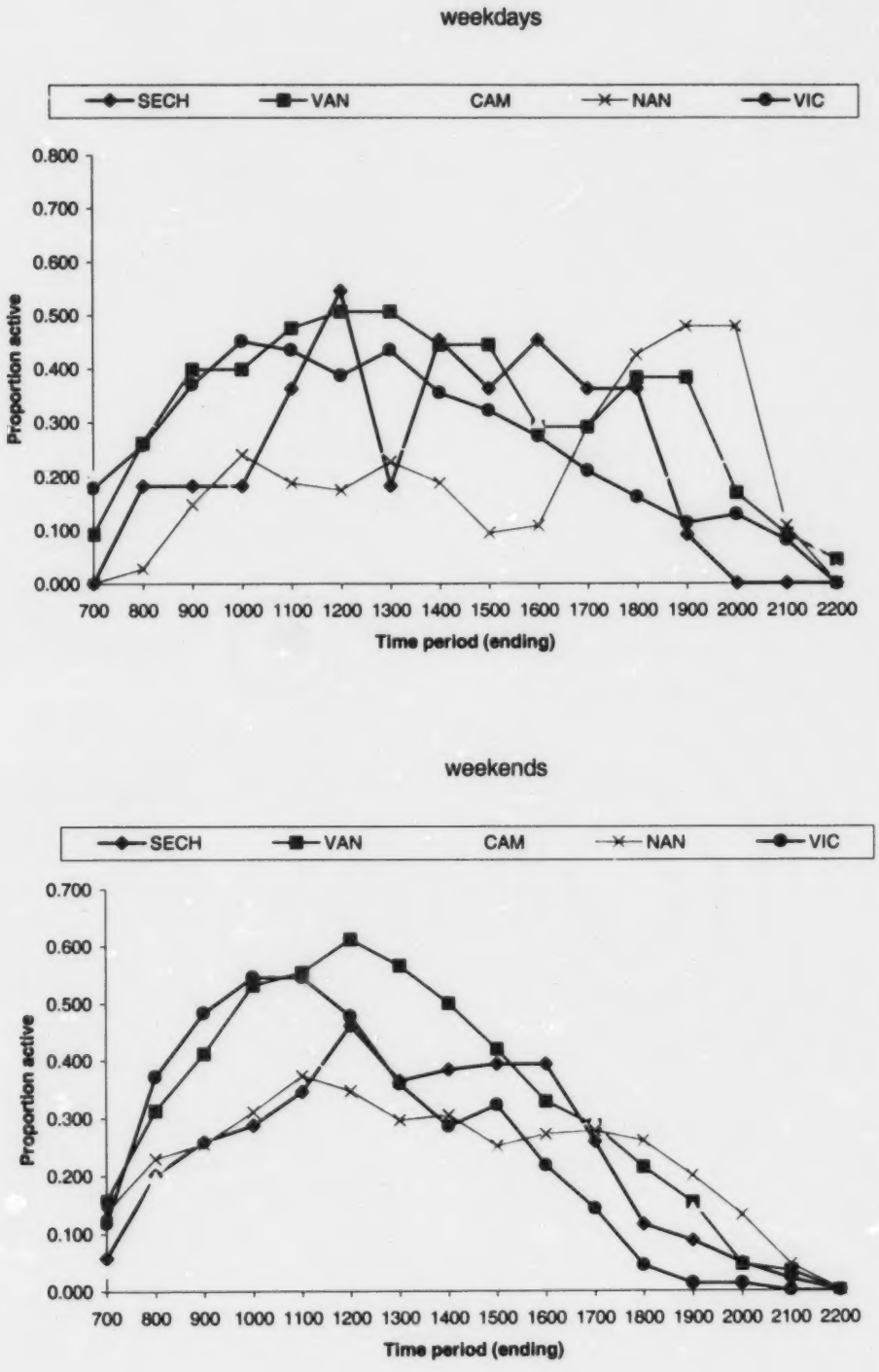
which is based on the standard formula for combining the variance of the product of two independent random variables (Goodman 1960).

Standard Error of the Effort Estimates

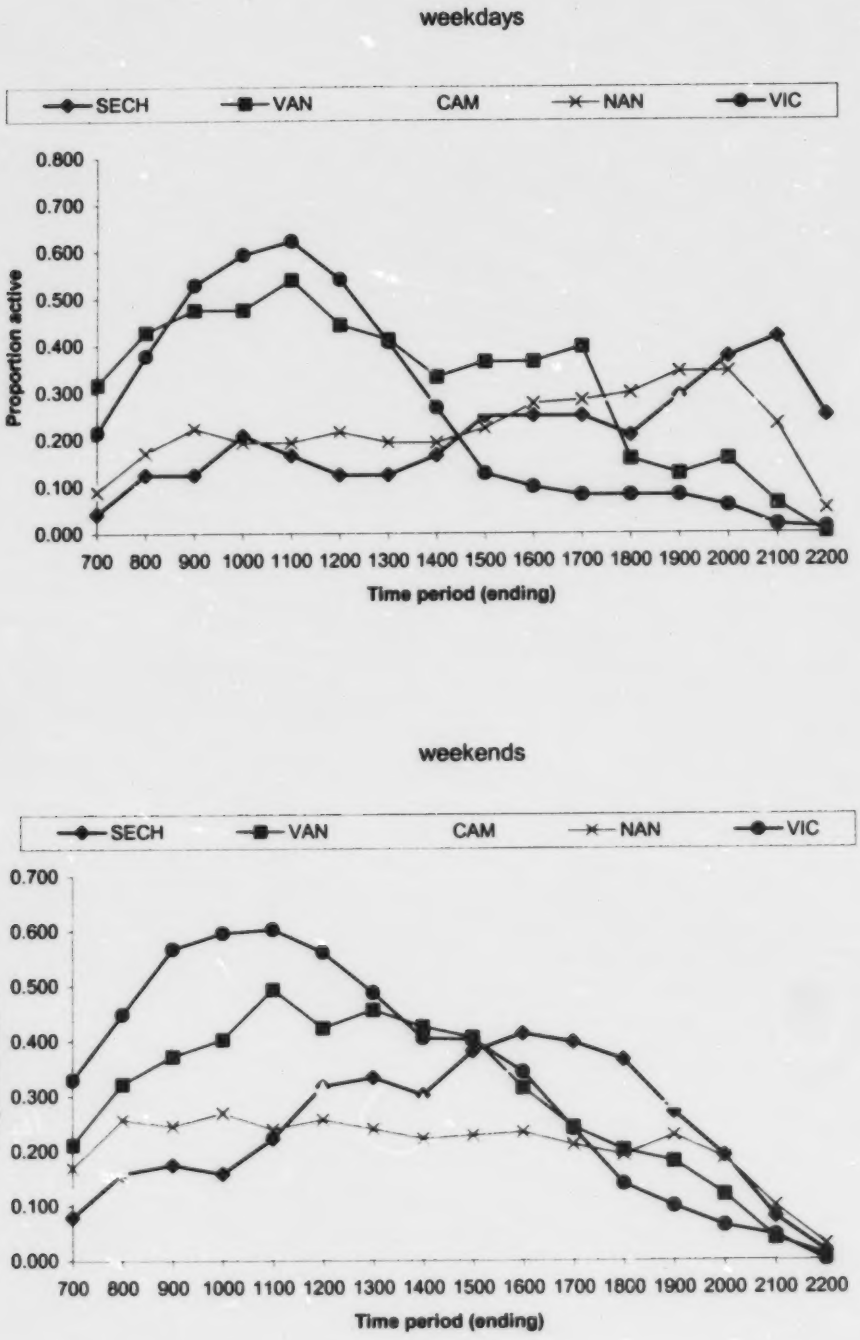
The standard error for the effort estimate for each sub-area was derived using following equation:

$$SE_{E_s} = \sqrt{\sum_{d}\left(\frac{S_{E_{ds}}^{2}}{n_{ds}} \right)} \quad (16)$$

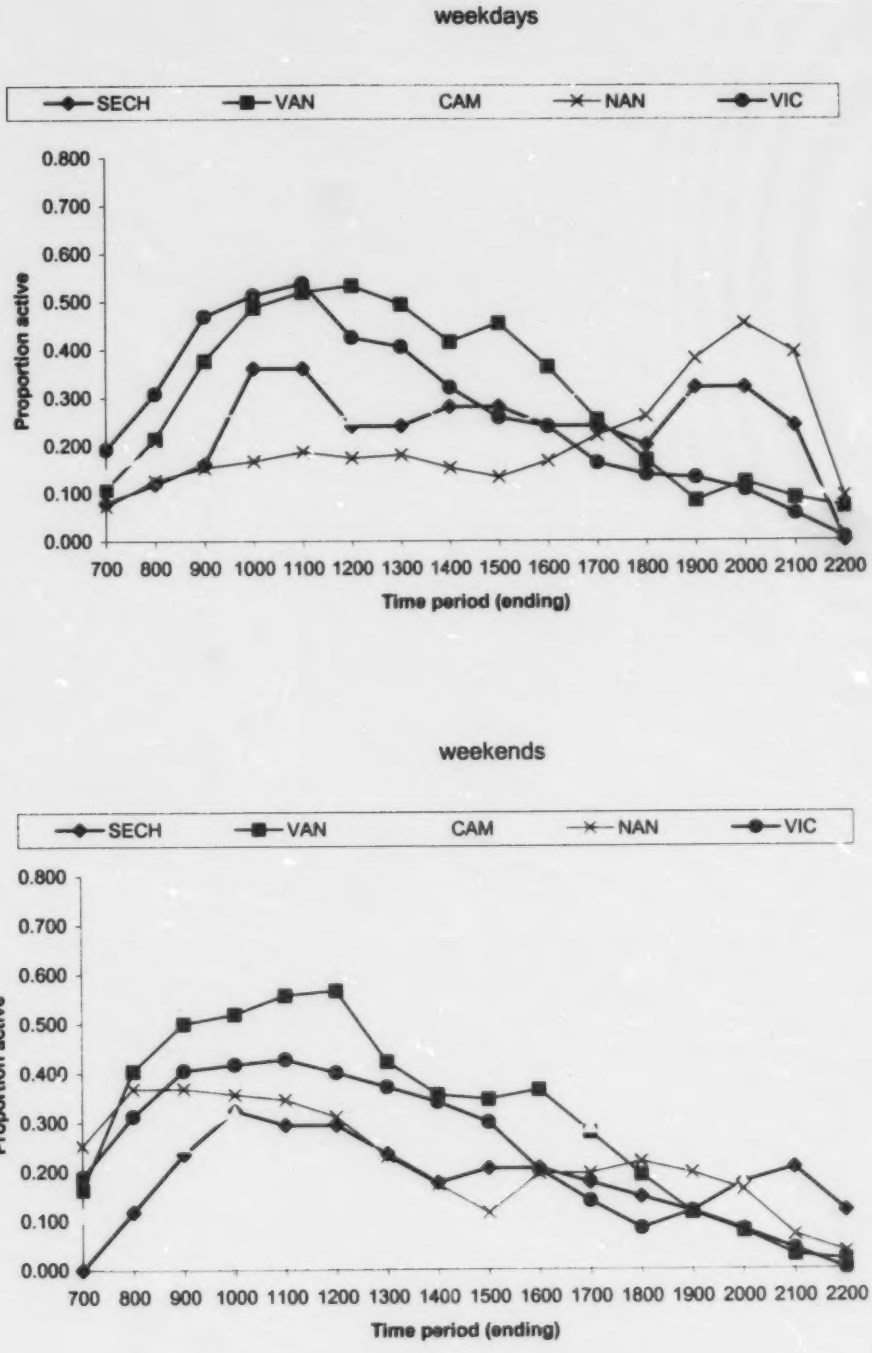
where all variable are as described above.



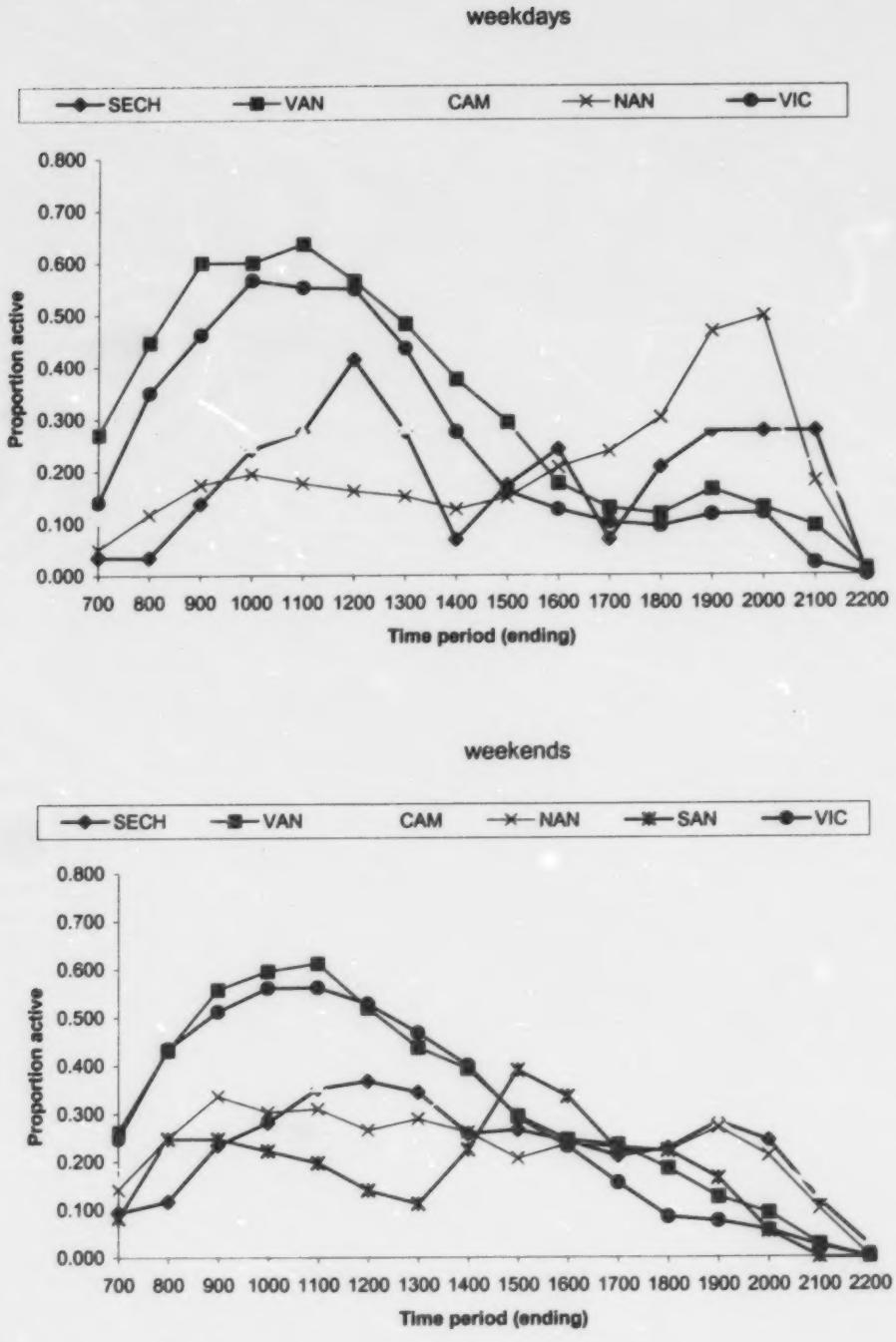
Appendix Figure C1. Sportfishing activity patterns for May 1998.



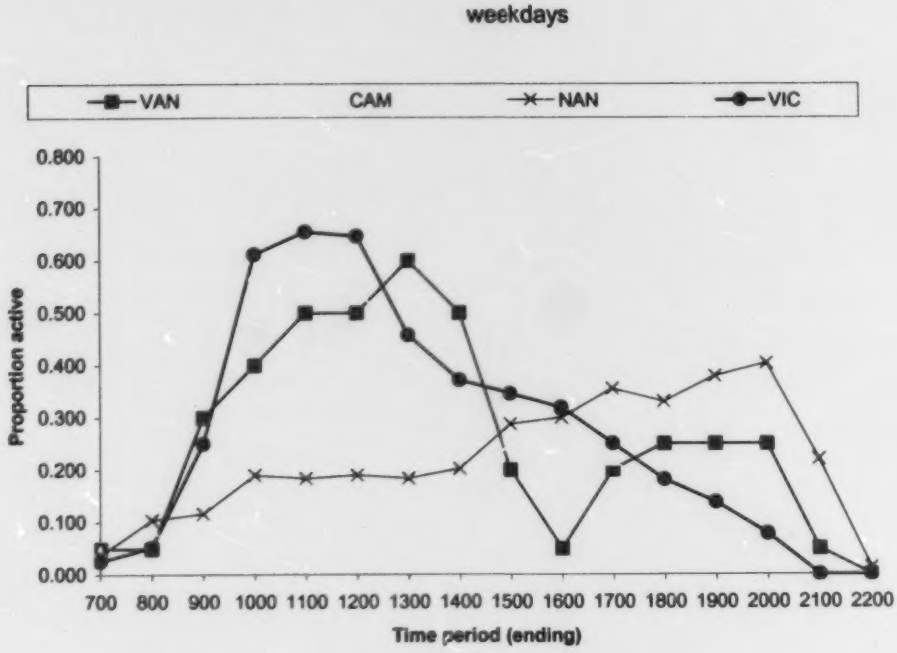
Appendix Figure C2. Sportfishing activity patterns for June 1998.

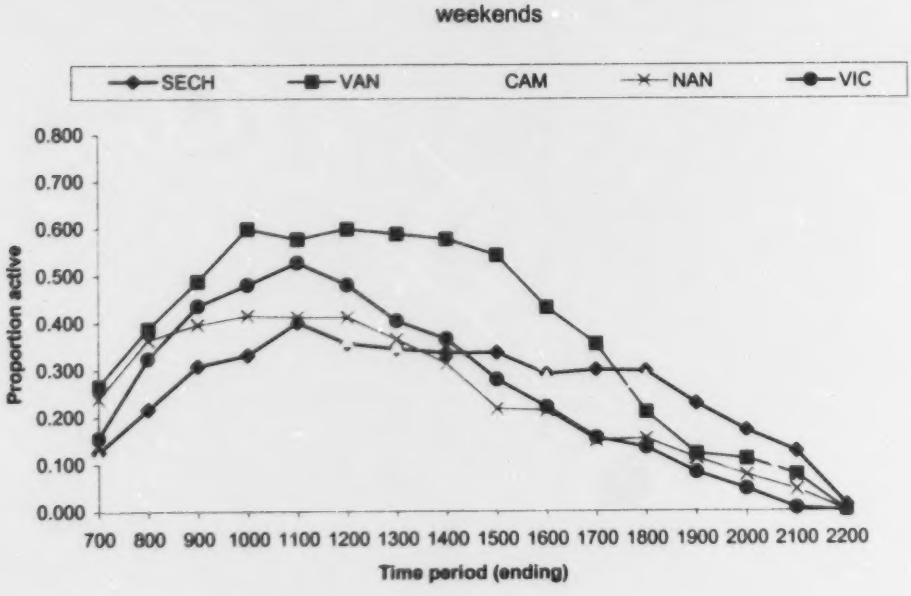


Appendix Figure C3. Sportfishing activity patterns for July 1998.

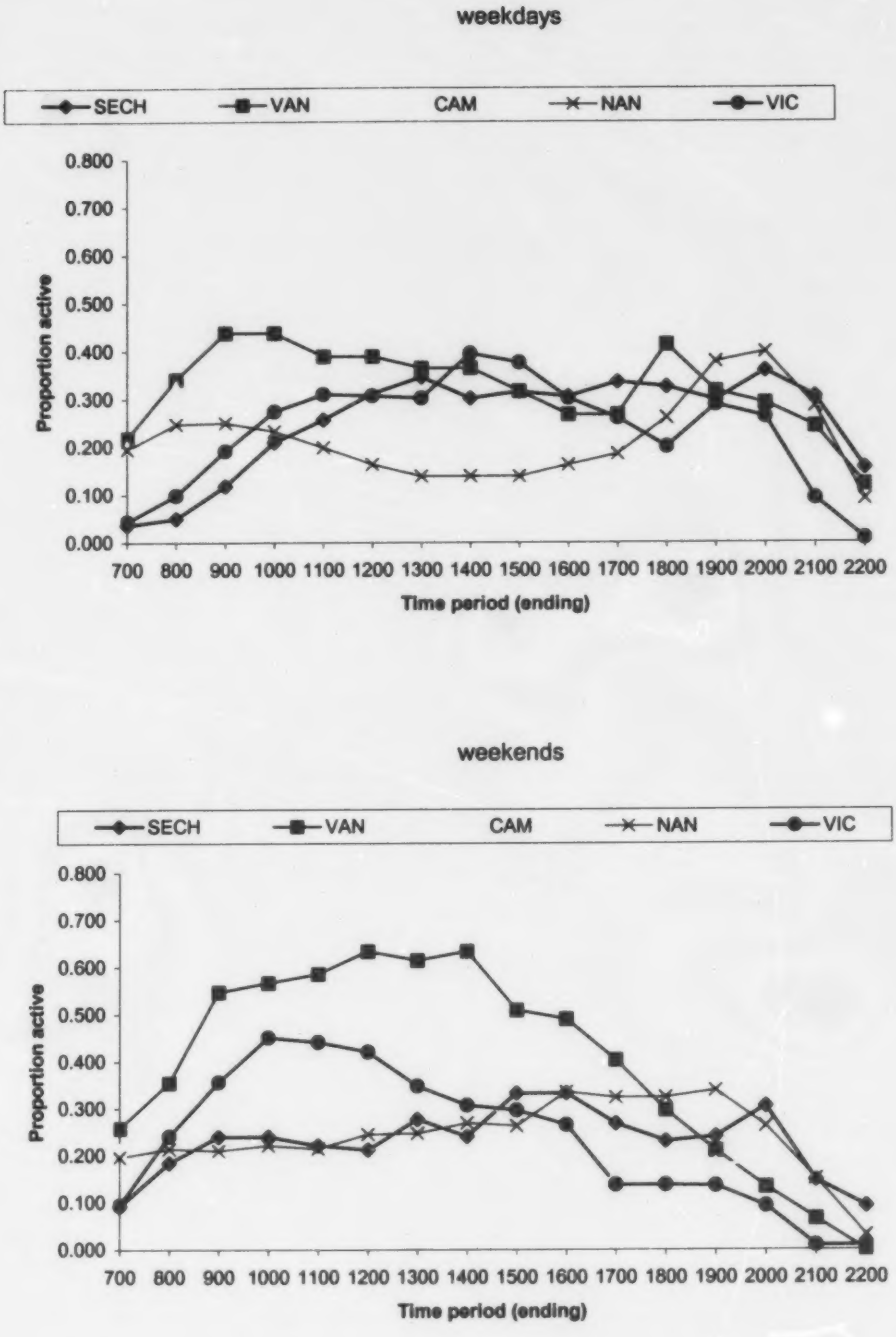


Appendix Figure C4. Sportfishing activity patterns for August 1998.

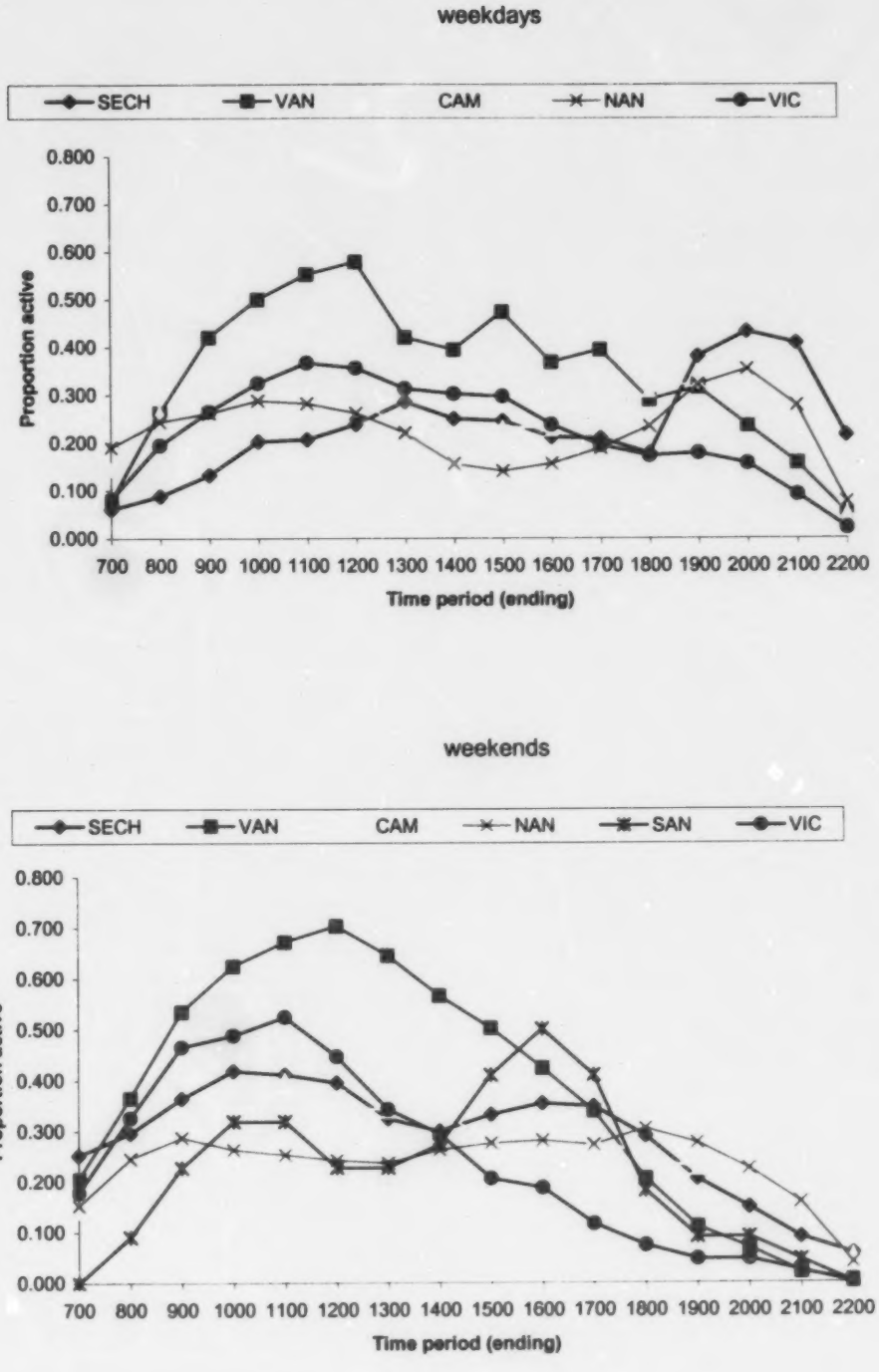




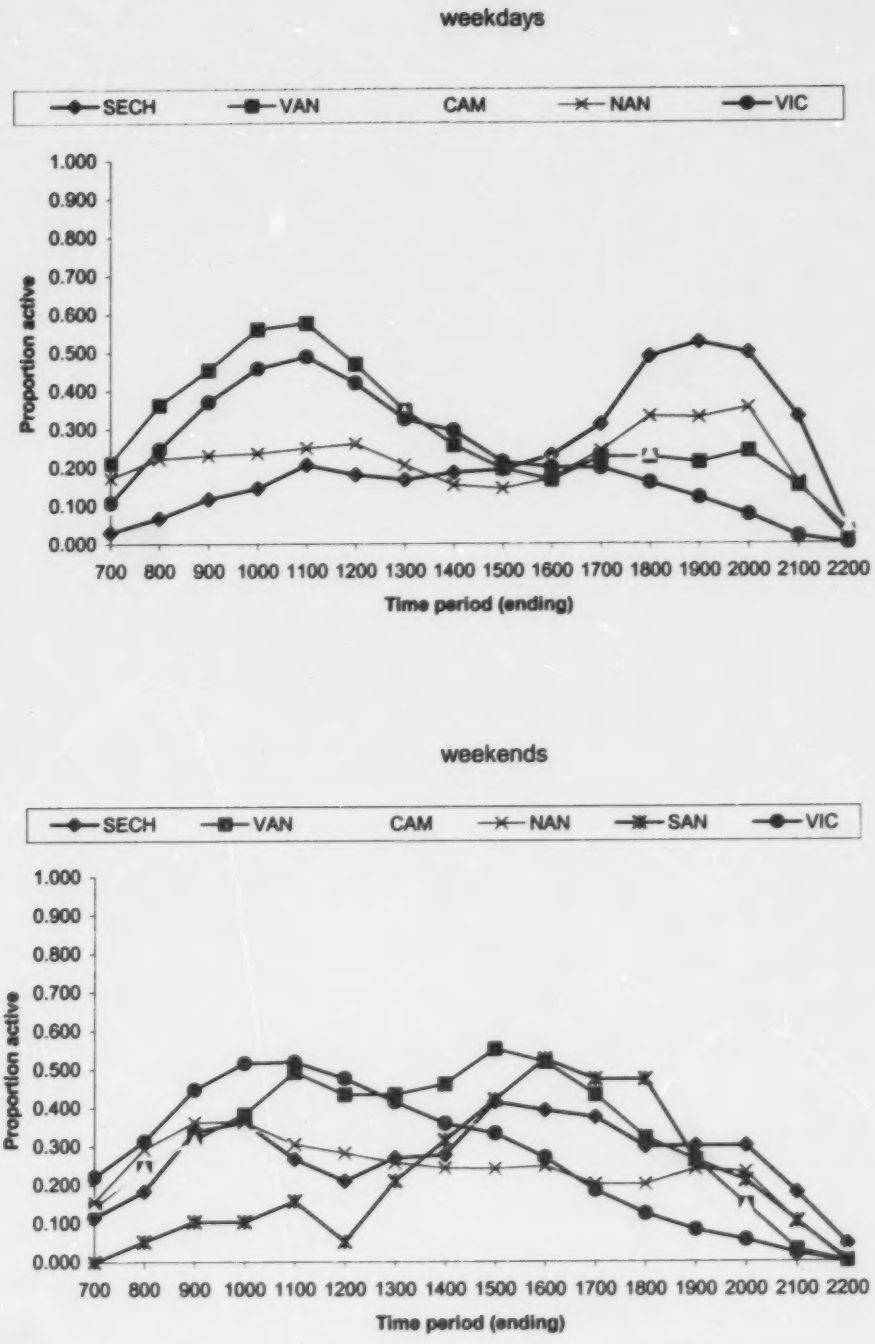
Appendix Figure C5. Sportfishing activity patterns for May 1999.



Appendix Figure C6. Sportfishing activity patterns for June 1999.



Appendix Figure C7. Sportfishing activity patterns for July 1999.



Appendix Figure C8. Sportfishing activity patterns for August 1999.

Appendix Table D1. Monthly effort statistics derived from the 1983-99 Strait of Georgia creel survey data.

Effort Estimates (Boat Trips)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	5996	5984	16511	19887	40535	102166	113209	118822	101138	39832	5094	5089	574263	495757
1984	6605	6586	9647	33885	61065	111715	153083	156481	79769	13589	9321	9342	651088	595998
1985	4398	4384	11066	26859	71817	100667	121383	152554	103605	16436	7681	7666	628516	576885
1986	7745	7722	10474	20938	61359	87351	111514	166945	75165	20393	6680	6685	582971	523272
1987	9286	9180	9532	18497	67970	105494	122106	146363	64617	26065	5267	5254	589631	525047
1988	8907	8890	13041	19981	73084	127251	174412	141492	54169	27439	7935	7769	664370	590389
1989	7657	7662	13913	17206	71494	95167	123871	131383	93847	18757	11185	11189	603331	532968
1990	4740	4744	12615	18753	59441	95585	129811	125761	67397	15395	4160	4164	542566	496748
1991	4486	4491	8301	15091	47780	70490	91171	99346	85498	33752	3171	3172	466749	409376
1992	4545	4549	15137	24766	55251	79958	123560	82213	56340	14547	3340	3353	467559	422088
1993	5909	5928	5442	21635	53900	108392	103837	106809	86174				498026	480747
1994				12683	45660	95574	101989	97968	69748	17122			440744	423622
1995			3450	12510	25962	66293	64263	72340	65481	13343			323642	306849
1996				8382	22029	53208	72322	81577	51218				288736	288736
1997				8841	31943	34581	50829	91394	40692	10517			268797	258280
1998				11628	15313	32762	32359	43600	22897	3734			162293	158559
1999				9617	9426	34978	40168	41075	26058	2965			164287	161322
Mean	6389	6375	10761	17715	47884	82449	101758	109184	67283	18259	6383	6368	465739	426273

Standard Error

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	1237	1237	1103	2375	3120	5028	5363	4767	8983	4382	926	926	14072	13147
1984	667	667	965	2163	5077	4443	4441	5752	2953	902	784	784	10751	10570
1985	431	432	821	1699	4920	3801	3090	4890	4454	1097	1678	1678	10135	9739
1986	1238	1238	734	2688	3564	3893	3048	4498	4130	1079	1100	1100	9426	9036
1987	1350	1350	984	1207	4128	5529	6805	5984	2655	1924	707	1778	12256	11757
1988	1977	1977	1007	1942	6087	5840	6941	5917	3110	2917	1374	1373	13744	12954
1989	1596	1596	1655	1418	5547	4348	4211	4901	3851	1909	1246	1246	11083	10405
1990	1269	1269	1239	1691	4183	5494	4526	5068	2776	1900	1272	1272	10771	10218
1991	1226	1226	988	1202	3558	6321	5109	4979	3931	3447	834	834	11732	10973
1992	905	905	1110	3556	6125	5158	31249	4324	5396	1790	510	510	33282	33183
1993	1114	1114	669	2470	4140	7339	4856	5716	5589				12943	12830
1994				1112	2773	5175	5671	5431	2429	3633			10792	10162
1995			300	918	1772	5998	3412	5153	20210	1205			22094	22059
1996				902	1415	3002	3629	4394	3508				7524	7524
1997				585	3261	3127	2672	4902	3417	828			8018	7975
1998				926	1282	2285	1913	2593	1902	432			4681	4661
1999				855	1183	3395	1832	2283	1965	538			5136	5108
Mean	1183	1183	965	1630	3655	4716	5810	4797	4780	1866	1043	1150	12261	11900

Coefficient of Variation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	20.6	20.7	6.7	11.9	7.7	4.9	4.7	4.0	8.9	11.0	18.2	18.2	2.5	2.7
1984	10.1	10.1	10.0	6.4	8.3	4.0	2.9	3.7	3.7	6.6	8.4	8.4	1.7	1.8
1985	9.8	9.8	7.4	6.3	6.9	3.8	2.5	3.2	4.3	6.7	21.8	21.9	1.6	1.7
1986	16.0	16.0	7.0	12.8	5.8	4.5	2.7	2.7	5.5	5.3	16.5	16.5	1.6	1.7
1987	14.5	14.7	10.3	6.5	6.1	5.2	5.6	4.1	4.1	7.4	13.4	13.8	2.1	2.2
1988	22.2	22.2	7.7	9.7	8.3	4.6	4.0	4.2	5.7	10.6	17.3	17.7	2.1	2.2
1989	20.8	20.8	11.9	8.2	7.8	4.6	3.4	3.7	4.1	10.2	11.1	11.1	1.8	2.0
1990	26.8	26.7	9.8	9.0	7.0	5.7	3.5	4.0	4.1	12.3	30.6	30.6	2.0	2.1
1991	27.3	27.3	11.9	8.0	7.4	9.0	5.6	5.0	4.6	10.2	26.3	26.3	2.5	2.7
1992	19.9	19.9	7.3	14.4	11.1	6.5	**25.3**	5.3	9.6	12.3	15.3	15.2	7.1	7.9
1993	18.8	18.8	12.3	11.4	7.7	6.8	4.7	5.4	6.5				2.6	2.7
1994				8.8	6.1	5.4	5.6	5.5	3.5	21.2			2.4	2.4
1995			8.7	7.3	6.8	9.0	5.3	7.1	**30.9**	9.0			6.8	7.2
1996				10.8	6.4	5.6	5.0	5.4	6.8				2.6	2.6
1997				6.6	10.2	9.0	5.3	5.4	8.4	7.9			3.0	3.1
1998				8.0	8.4	7.0	5.9	5.9	8.3	11.6			2.9	2.9
1999				8.9	12.6	9.7	4.6	5.6	7.5	18.2			3.1	3.2
Means														
1983-99	18.8	18.8	9.3	9.1	7.9	6.2	5.7	4.7	7.4	10.7	17.9	20.0	2.8	3.0
1983-89	16.3	16.3	8.7	8.9	7.3	4.5	3.7	3.7	5.2	8.3	15.3	18.2	1.9	2.0
1990,91,93,94,96				9.8	7.7	7.1	4.9	5.1	5.1				2.4	2.5

Appendix Table D2. Monthly chinook catch statistics derived from the 1983-99 Strait of Georgia creel survey data.

Chinook Catch Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	4037	4023	9391	3843	6695	27656	37250	37441	37635	20471	4995	4988	198425	150520
1984	4412	4401	5364	17809	35380	96792	95904	58164	29673	6717	7406	7420	369442	333722
1985	2925	2911	3901	8185	44809	56492	36208	38144	21275	3553	8227	8212	234842	205113
1986	5082	5058	5022	8026	25649	43384	26551	36961	14236	1962	4993	4978	181902	154807
1987	5644	5628	3431	5788	20066	27630	18689	18596	9370	3081	1588	1577	121088	100139
1988	6861	6845	4702	4148	12101	26887	24873	16966	5475	2456	3892	3779	118985	90450
1989	5420	5425	1774	2512	21895	24914	21019	23080	10457	1461	7442	7447	132846	103877
1990	3661	3666	5207	4660	14697	26818	21958	17291	5203	1154	3727	3731	111773	90627
1991	2415	2420	2907	2859	16239	36809	17619	16429	11735	3267	1409	1414	115522	101690
1992	2702	2706	4256	7618	22247	26419	24083	12962	7014	1652	2456	2464	116579	100343
1993	2281	2299	1142	4063	26131	41772	15483	18343	7331				118845	113123
1994				2144	9534	18471	15465	12922	4920	1292			64748	63456
1995			853	2255	4281	15548	15412	13877	7711	2236			62173	59084
1996				1649	6746	26199	25922	21216	7773				89505	89505
1997				1824	8504	14718	9878	15801	4829	778			56332	55554
1998				1622	1182	4175	4143	7163	2251	386			20922	20536
1999				1814	2618	12931	11193	11157	3850	28			43591	43563
Mean	4131	4126	3996	4754	16398	31036	24803	22148	11220	3366	4614	4601	126913	110359

Standard Error

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	823	823	851	571	585	1335	2170	1884	3299	3392	1675	1675	6386	4647
1984	688	688	897	1431	3350	4527	3920	2726	1537	776	926	926	7937	7676
1985	396	396	558	842	3249	2577	1340	1909	1178	387	3257	3257	6835	4973
1986	1554	1554	457	1168	1666	2449	1035	1571	1242	256	1182	1182	4808	3901
1987	1048	1048	763	595	1801	2052	1323	1082	610	418	251	251	3765	3331
1988	2711	2711	670	1023	1346	1529	1200	968	554	475	1067	1058	5051	2808
1989	1931	1931	428	394	2470	1448	1155	1281	862	281	1108	1108	4716	3474
1990	1312	1312	820	627	1465	1752	1233	907	472	517	1776	1776	4344	2859
1991	1011	1011	575	374	2011	5281	1229	1221	967	671	676	676	6305	6001
1992	1114	1114	439	1512	3246	1770	3258	876	957	492	628	628	5654	5316
1993	834	834	189	1071	2500	3645	998	1457	643				5064	4921
1994				279	809	1313	1915	1045	416	343			2740	2718
1995			116	300	482	1976	1074	1371	4443	601			5232	5196
1996				314	841	1861	1389	1364	727				2931	2931
1997				228	1341	1668	626	1295	646	208			2676	2668
1998				381	177	513	483	842	406	187			1257	1243
1999				340	630	1714	867	914	566	18			2315	2315
Mean	1220	1220	564	674	1645	2201	1483	1336	1148	602	1255	1254	4589	3940

Coefficient of Variation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	20.4	20.4	9.1	14.9	8.7	4.8	5.8	5.0	8.8	16.6	33.5	33.6	3.2	3.1
1984	15.6	15.6	16.7	8.0	9.5	4.7	4.1	4.7	5.2	11.6	12.5	12.5	2.1	2.3
1985	13.5	13.6	14.3	10.3	7.3	4.6	3.7	5.0	5.5	10.9	39.6	39.7	2.9	2.4
1986	30.6	30.7	9.1	14.5	6.5	5.6	3.9	4.3	8.7	13.1	23.7	23.7	2.6	2.5
1987	18.6	18.6	22.3	10.3	9.0	7.4	7.1	5.8	6.5	13.6	15.8	15.9	3.1	3.3
1988	39.5	39.6	14.3	24.7	11.1	5.7	4.8	5.7	10.1	19.4	27.4	28.0	4.2	3.1
1989	35.6	35.6	24.1	15.7	11.3	5.8	5.5	5.5	8.2	19.2	14.9	14.9	3.6	3.3
1990	35.8	35.8	15.7	13.5	10.0	6.5	5.6	5.2	9.1	44.8	47.7	47.6	3.9	3.2
1991	41.9	41.8	19.8	13.1	12.4	14.3	7.0	7.4	8.2	20.5	48.0	47.8	5.5	5.9
1992	41.2	41.2	10.3	19.9	14.6	6.7	13.5	6.8	13.6	29.8	25.6	25.5	4.8	5.3
1993	36.6	36.3	16.5	26.4	9.6	8.7	6.4	7.9	8.8				4.3	4.4
1994				13.0	8.5	7.1	12.4	8.1	8.5	26.5			4.2	4.3
1995			13.5	13.3	11.3	12.7	7.0	9.9	57.6	26.9			8.4	8.8
1996				19.0	12.5	7.1	5.4	6.4	9.3				3.3	3.3
1997				12.5	15.8	11.3	6.3	8.2	13.4	26.8			4.8	4.8
1998				23.5	15.0	12.3	11.7	11.7	18.0	48.4			6.0	6.1
1999				18.8	24.1	13.3	7.7	8.2	14.7	64.5			5.3	5.3
Means														
1983-99	29.9	29.9	15.5	16.0	11.6	8.2	6.9	6.8	12.6	26.2	28.9	28.9	4.3	4.2
1983-89	24.8	24.9	15.7	14.1	9.0	5.5	5.0	5.1	7.6	14.9	23.9	24.0	3.1	2.9
1990,91,93,94,96				16.5	11.0	9.4	7.4	7.0	8.8				4.2	4.2

Appendix Table D3. Monthly coho catch statistics derived from the 1983-99 Strait of Georgia creel survey data.

Coho Catch Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	913	910	3230	5847	32399	151360	102947	50848	39509	15628	222	220	404033	382910
1984	602	596	3700	30907	58225	86436	136076	74660	46231	3983	1083	1090	443589	432535
1985	538	537	6202	44272	96789	173635	192520	141475	66370	5460	205	200	728203	715061
1986	455	445	7782	20381	95084	93858	158869	128559	53975	11754	413	408	571983	550726
1987	1161	1152	1373	19674	62881	149765	198359	133614	57456	14909	618	610	641572	621749
1988	7625	7609	12608	57859	189840	351915	287648	118546	36488	11921	1266	1255	1084580	1042296
1989	1550	1552	8070	25072	65000	89244	157563	86359	49389	11071	1175	1178	497223	472627
1990	1305	1308	6762	19808	73501	200326	158751	84525	64849	17851	210	213	629409	601760
1991	39	39	24	3281	2285	7742	29453	24366	59725	29843	155	159	157111	126852
1992	1057	1060	14418	66170	91276	169136	148081	61962	34834	7297	129	133	595553	571459
1993	3293	3297	8447	46622	89785	295920	198239	123540	69588				838731	823694
1994				5266	4956	99911	45823	35178	87756	13275			292165	278890
1995			42	81	71	10524	23719	14231	24454	13023			86145	73080
1996				755	983	9484	49741	26508	40391				127862	127862
1997				13	0	12335	28878	25655	31672	6400			104953	98553
1998				0	78	32	328	978	417				1833	1833
1999				0	0	12	10	19	272	163			476	313
Mean	1685	1682	6055	20353	50774	111861	112765	66531	44904	11613	548	547	423848	407188

Standard Error

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	247	247	471	619	4458	8929	6200	3156	5324	2432	132	132	13529	13294
1984	487	487	721	2889	8394	4820	6154	4021	3030	543	472	472	12922	12855
1985	197	197	1070	3390	8845	9854	6560	5139	3913	636	117	117	16530	16480
1986	123	123	1051	3213	10905	6750	6006	4412	4562	1377	141	141	15944	15848
1987	387	387	261	1358	7174	11699	15162	6748	3197	2053	183	183	21919	21813
1988	2134	2134	1948	9208	20070	22162	12292	6046	3193	1880	411	411	34546	34302
1989	647	647	2111	4445	8326	6094	8073	4369	3143	2424	349	349	15224	14844
1990	605	605	1237	2123	8043	16484	7834	4213	4300	5468	167	167	21697	20942
1991	36	36	18	734	501	1324	3323	2273	4340	6708	85	85	9088	6131
1992	389	389	2070	14497	14966	16803	27011	4153	4922	2441	54	54	38705	38568
1993	901	901	2680	8664	7050	22095	10636	7748	6544				28943	28791
1994				1078	805	9792	4255	2157	3990	6218			13230	11678
1995			25	44	61	2749	2935	1261	5248	2542			7195	6731
1996				324	181	861	2163	2122	3630				4821	4821
1997				10	0	3286	3722	1812	5653	954			7797	7739
1998				0	58	31	91	204	91				250	250
1999				0	0	9	6	8	66	49			83	67
Mean	559	559	1139	3094	5873	8455	7201	3520	3832	2552	211	211	15437	15009

Coefficient of Variation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sep
1983	27.0	27.1	14.6	10.6	13.8	5.9	6.0	6.2	13.5	15.6	59.4	59.9	3.3	3.5
1984	80.9	81.7	19.5	9.3	14.4	5.6	4.5	5.4	6.6	13.6	43.6	43.3	2.9	3.0
1985	36.6	36.7	17.2	7.7	9.1	5.7	3.4	3.6	5.9	11.6	57.0	58.4	2.3	2.3
1986	27.0	27.6	13.5	15.8	11.5	7.2	3.8	3.4	8.5	11.7	34.2	34.6	2.8	2.9
1987	33.4	33.6	19.0	6.9	11.4	7.8	7.6	5.1	5.6	13.8	29.6	30.0	3.4	3.5
1988	28.0	28.0	15.4	15.9	10.6	6.3	4.3	5.1	8.8	15.8	32.4	32.7	3.2	3.3
1989	41.8	41.7	26.2	17.7	12.8	6.8	5.1	5.1	6.4	21.9	29.7	29.6	3.1	3.1
1990	46.4	46.3	18.3	10.7	10.9	8.2	4.9	5.0	6.6	30.6	79.4	78.3	3.4	3.5
1991	93.2	93.2	75.1	22.4	21.9	17.1	11.3	9.3	7.3	22.5	54.8	53.4	5.8	4.8
1992	36.8	36.7	14.4	21.9	16.4	9.9	18.2	6.7	14.1	33.5	41.7	40.4	6.5	6.7
1993	27.4	27.3	31.7	18.6	7.9	7.5	5.4	6.3	9.4				3.5	3.5
1994				20.5	16.3	9.8	9.3	6.1	4.5	46.8			4.5	4.2
1995			59.9	54.3	85.4	26.1	12.4	8.9	21.5	19.5			8.4	9.2
1996				42.9	18.5	9.1	4.3	8.0	9.0				3.8	3.8
1997				80.3		26.6	12.9	7.1	17.8	14.9			7.4	7.9
1998					73.7	97.0	27.7	20.8	21.7				13.6	13.6
1999						75.9	59.2	40.8	24.2	30.3			17.5	21.5
Means														
1983-99	43.5	43.6	27.1	23.7	22.3	19.6	11.8	9.0	11.3	21.6	46.2	46.1	5.6	5.9
1983-89	39.2	39.5	17.9	12.0	11.9	6.5	5.0	4.8	7.9	14.9	40.8	41.2	3.0	3.1
1990,91,93,94,96				24.7	26.5	13.1	7.0	6.9	7.4				4.2	4.0

Appendix Table E1. Summary of three recommended aerial survey options by month and daytype.

	1998		1999	
	P. active	% of Max	P. active	% of Max
Option 1				
Weekdays				
May	0.26	65%	0.39	73%
June	0.27	61%	0.27	67%
July	0.26	57%	0.27	61%
August	0.27	58%	0.23	53%
September	0.29	64%	0.32	70%
Mean	**0.27**	**61%**	**0.30**	**65%**
Weekends				
May	0.31	75%	0.38	81%
June	0.26	64%	0.31	74%
July	0.31	76%	0.32	69%
August	0.29	66%	0.33	72%
September	0.39	77%	0.37	72%
Mean	**0.31**	**71%**	**0.34**	**74%**
Option 2				
Weekdays				
May	0.29	70%	0.39	70%
June	0.32	70%	0.31	79%
July	0.30	64%	0.29	68%
August	0.33	72%	0.28	52%
September	0.28	64%	0.37	79%
Mean	**0.30**	**68%**	**0.33**	**70%**
Weekends				
May	0.35	79%	0.43	90%
June	0.32	77%	0.36	89%
July	0.36	87%	0.35	75%
August	0.34	77%	0.30	69%
September	0.31	61%	0.34	65%
Mean	**0.34**	**76%**	**0.36**	**77%**
Option 3				
Weekdays				
May	0.28	68%	0.34	63%
June	0.29	64%	0.27	67%
July	0.29	61%	0.28	64%
August	0.31	64%	0.32	68%
September	0.34	76%	0.37	80%
Mean	**0.30**	**66%**	**0.32**	**68%**
Weekends				
May	0.38	87%	0.47	93%
June	0.38	88%	0.32	76%
July	0.34	82%	0.37	74%
August	0.36	82%	0.27	60%
September	0.33	69%	0.44	82%
Mean	**0.36**	**81%**	**0.37**	**77%**

Appendix Table E2. Three recommended aerial survey options for each region by month and daytype.

Option 1. Vancouver north to Stuart Island then south to Victoria, May and June 1998.

Weekdays		######	% of Max	May-99	% of Max		Jun-98	% of Max	Jun-99	% of Max
Vancouver	0800-0840	0.400	79%	0.300	60%	0800-0840	0.429	79%	0.439	100%
Sechelt	0840-1030	0.182		0.500	100%	0840-1030	0.125	30%	0.21	58%
Stuart Island	1030-1050					1030-1050				
Campbell Rive	1050-1125	0.200	67%	0.559	90%	1050-1125	0.243	77%	0.316	82%
Comox	1125-1145					1125-1145	0.276	68%	0.173	43%
Qualicum	1145-1205	0.173	53%	0.446	83%	1145-1205	0.221	46%	0.191	52%
Nanaimo	1205-1245	0.227	47%	0.183	46%	1205-1245	0.216	63%	0.139	35%
Saanich	1245-1250					1245-1250				
Victoria	1250-1350	0.355	79%	0.371	57%	1250-1350	0.407	65%	0.396	100%
Mean		0.256	65%	0.393	73%		0.274	61%	0.266	67%
Weekends										
Vancouver	0800-0840	0.314	51%	0.489	82%	0900-0940	0.372	75%	0.567	89%
Sechelt	0840-1030	0.260	56%	0.331	83%	0940-1130	0.159	38%	0.222	67%
Stuart Island	1030-1050					1130-1150				
Campbell Rive	1050-1125	0.424	116%	0.364	93%	1150-1225	0.315	89%	0.371	88%
Comox	1125-1145	0.333	100%	0.455	56%	1225-1245	0.089	16%	0.344	100%
Qualicum	1145-1205	0.154	43%	0.315	95%	1245-1305	0.237	72%	0.099	31%
Nanaimo	1205-1245	0.347	93%	0.364	88%	1305-1345	0.24	89%	0.27	80%
Saanich	1245-1250					1345-1350				
Victoria	1250-1350	0.360	66%	0.366	69%	1350-1450	0.404	67%	0.297	66%
Mean		0.313	75%	0.383	81%		0.259	64%	0.310	74%

Option 2. Vancouver to Victoria then north to Stuart Island then south to Sechelt, May and June 1998.

Weekdays		######	% of Max	May-99	% of Max		Jun-98	% of Max	Jun-99	% of Max
Vancouver	0900-0940	0.4	79%	0.4	80%	0800-0840	0.476	88%	0.439	100%
Victoria	0940-1040	0.435	96%	0.655	100%	0840-0940	0.593	95%	0.275	69%
Saanich	1040-1045					0940-0945				
Nanaimo	1045-1125	0.187	39%	0.189	47%	0945-1025	0.194	57%	0.234	59%
Qualicum	1125-1145	0.173	53%	0.446	83%	1025-1045	0.221	46%	0.368	100%
Comox	1145-1205					1045-1105	0.256	63%	0.173	43%
Campbell Rive	1205-1240	0.25	83%	0.382	62%	1105-1140	0.314	100%	0.316	82%
Stuart Island	1240-1300					1140-1200				
Sechelt	1300-1450			0.25	50%	1200-1350	0.167	40%	0.346	96%
Mean		0.289	70%	0.387	70%		0.317	70%	0.307	79%
Weekends										
Vancouver	0900-0940	0.533	87%	0.6	100%	0800-0840	0.372	75%	0.548	86%
Victoria	0940-1040	0.547	100%	0.528	100%	0840-0940	0.596	99%	0.452	100%
Saanich	1040-1045					0940-0945				
Nanaimo	1045-1125	0.374	100%	0.412	99%	0945-1025	0.269	100%	0.222	65%
Qualicum	1125-1145	0.128	35%	0.315	95%	1025-1045	0.268	81%	0.319	100%
Comox	1145-1205	0.222	67%	0.456	56%	1045-1105	0.089	16%	0.318	92%
Campbell Rive	1205-1240	0.282	77%	0.364	93%	1105-1140	0.315	89%	0.404	95%
Stuart Island	1240-1300					1140-1200				
Sechelt	1300-1450	0.394	85%	0.337	84%	1200-1350	0.333	81%	0.278	83%
Mean		0.354	79%	0.430	90%		0.320	77%	0.363	89%

Option3. Vancouver to Victoria to Nanaimo to Sechelt,to Stuart Island and to Qualicum, May and June 1998.

Weekdays		######	% of Max	May-99	% of Max		Jun-98	% of Max	Jun-99	% of Max
Vancouver	0900-0940	0.4	79%	0.4	80%	0900-0940	0.476	88%	0.439	100%
Victoria	0940-1040	0.435	96%	0.655	100%	0940-1040	0.622	100%	0.31	78%
Saanich	1040-1045					1040-1045				
Nanaimo	1045-1125	0.187	39%	0.189	47%	1045-1125	0.216	63%	0.199	50%
Sechelt	1125-1315			0.333	67%	1125-1315	0.125	30%	0.346	96%
Stuart Island	1315-1335					1315-1335				
Campbell Rive	1335-1410	0.25	83%	0.382	62%	1335-1410	0.298	95%	0.241	63%
Comox	1410-1430					1410-1430	0.248	61%	0.115	28%
Qualicum	1430-1450	0.136	42%	0.108	20%	1430-1450	0.059	12%	0.206	56%
Mean		0.282	68%	0.345	63%		0.292	64%	0.265	67%
Weekends										
Vancouver	0900-0940	0.533	87%	0.6	100%	1000-1040	0.494	100%	0.587	92%
Victoria	0940-1040	0.547	100%	0.528	100%	1040-1140	0.561	93%	0.421	93%
Saanich	1040-1045					1140-1145				
Nanaimo	1045-1125	0.374	100%	0.412	99%	1145-1225	0.257	96%	0.248	73%
Sechelt	1125-1315	0.462	100%	0.356	89%	1225-1415	0.333	81%	0.278	83%
Stuart Island	1315-1335					1415-1435				
Campbell Rive	1335-1410	0.318	87%	0.351	90%	1435-1510	0.319	90%	0.258	61%
Comox	1410-1430	0.278	83%	0.727	89%	1510-1530	0.467	84%	0.313	91%
Qualicum	1430-1450	0.174	48%	0.288	87%	1530-1550	0.237	72%	0.121	38%
Mean		0.384	87%	0.466	93%		0.381	88%	0.318	76%

Appendix Table E2. Continued

Option 1. Vancouver north to Stuart Island then south to Victoria, July and August 1998.

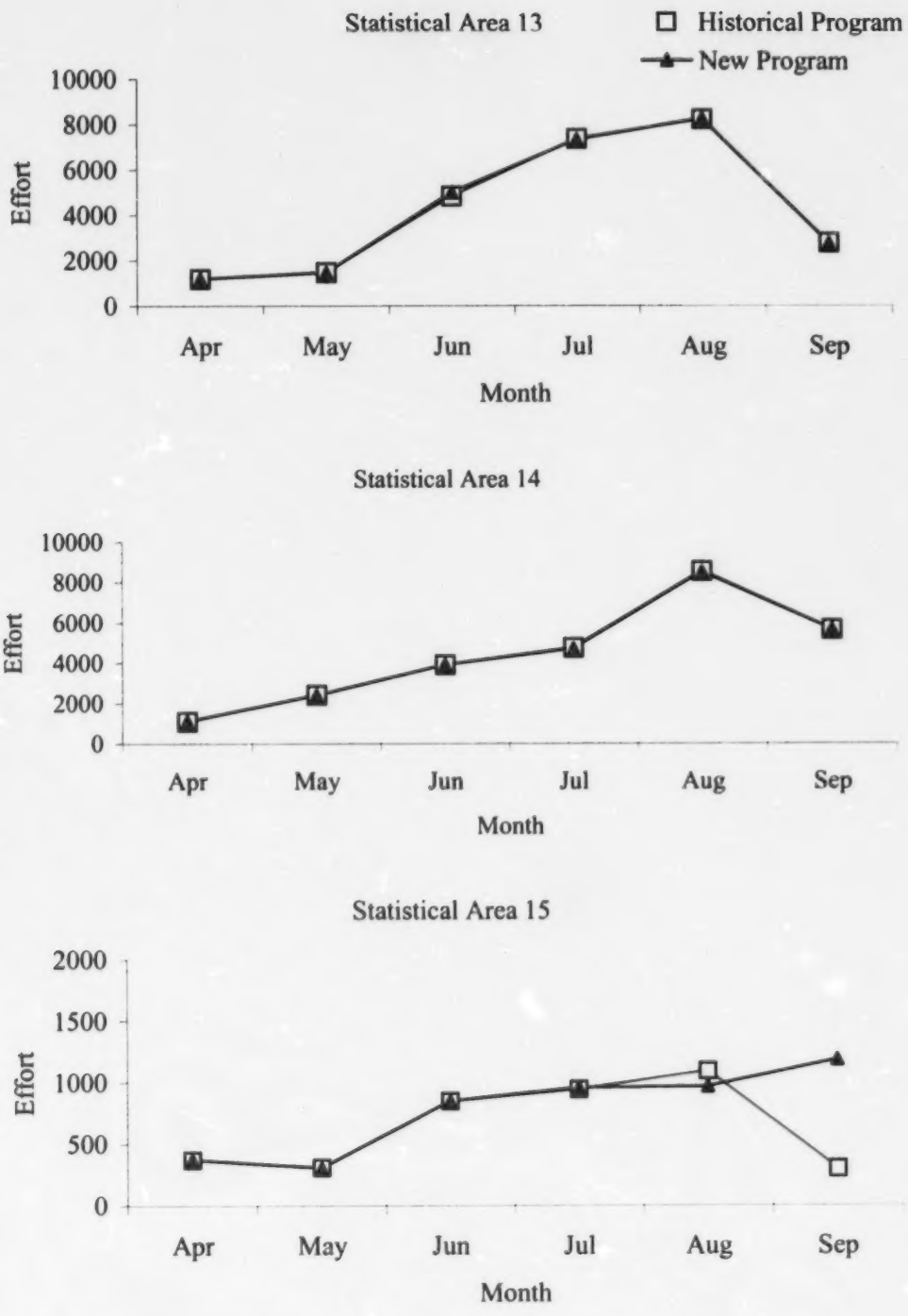
Weekdays		Jul-98	% of Max	Jul-99	% of Max		Aug-98	% of Max	Aug-99	% of Max
Vancouver	0900-0940	0.487	92%	0.500	86%	0700-0740	0.447	75%	0.364	63%
Sechelt	0940-1130	0.360	100%	0.207	48%	0740-0930	0.138	33%	0.118	23%
Stuart Island	1130-1150					0930-0950			0.053	8%
Campbell Rive	1150-1225	0.301	85%	0.226	60%	0950-1025	0.276	87%	0.389	96%
Comox	1225-1245	0.190	28%	0.167	29%	1025-1045	0.267	67%	0.143	40%
Qualicum	1245-1305	0.043	9%	0.326	81%	1045-1105	0.156	34%	0.219	56%
Nanaimo	1305-1345	0.153	34%	0.155	44%	1105-1145	0.162	33%	0.262	74%
Saanich	1345-1350					1145-1150				
Victoria	1350-1450	0.258	48%	0.297	81%	1150-1250	0.435	77%	0.326	67%
Mean		0.256	57%	0.268	61%		0.269	58%	0.234	53%
Weekends										
Vancouver	0700-0740	0.404	71%	0.365	52%	0800-0840	0.557	91%	0.319	58%
Sechelt	0740-0930	0.235	73%	0.364	87%	0840-1030	0.281	77%	0.363	87%
Stuart Island	0930-0950			0.400	67%	1030-1050			0.500	100%
Campbell Rive	0950-1025	0.379	100%	0.404	100%	1050-1125	0.312	90%	0.327	92%
Comox	1025-1045	0.222	50%	0.220	33%	1125-1145	0.200	30%	0.400	86%
Qualicum	1045-1105	0.268	65%	0.349	89%	1145-1205	0.151	39%	0.194	42%
Nanaimo	1105-1145	0.310	84%	0.242	80%	1205-1245	0.288	86%	0.257	71%
Saanich	1145-1150			0.227	45%	1245-1250	0.112	45%	0.211	45%
Victoria	1150-1250	0.371	89%	0.342	65%	1250-1350	0.400	71%	0.360	69%
Mean		0.313	76%	0.324	69%		0.288	66%	0.326	72%

Option 2. Vancouver to Victoria then north to Stuart Island then south to Sechelt, July and August 1998.

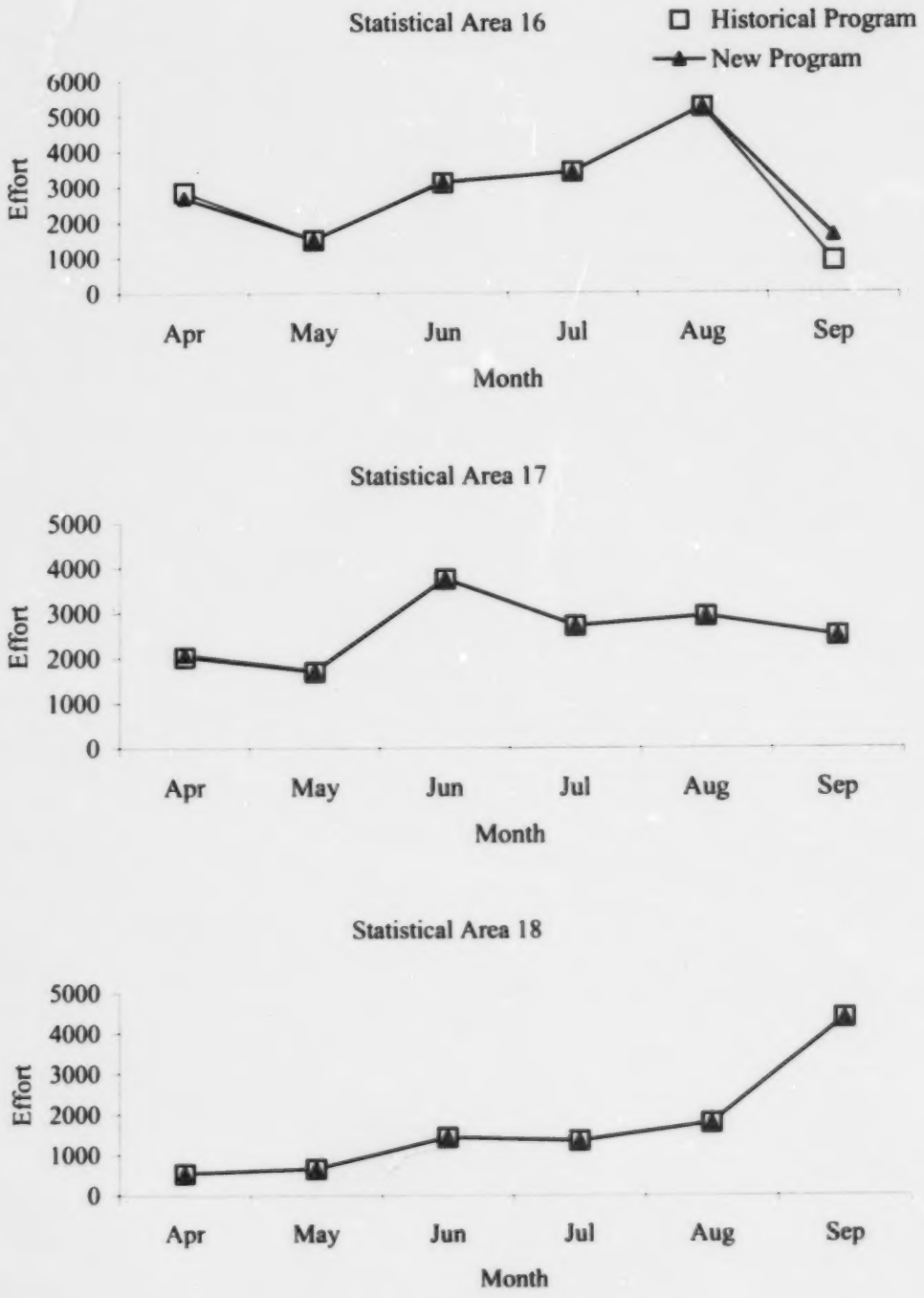
Weekdays		Jul-98	% of Max	Jul-99	% of Max		Aug-98	% of Max	Aug-99	% of Max
Vancouver	0900-0940	0.487	92%	0.500	86%	0700-0740	0.447	75%	0.364	63%
Victoria	0940-1040	0.538	100%	0.367	100%	0740-0840	0.462	82%		0%
Saanich	1040-1045					0840-0845			0.371	
Nanaimo	1045-1125	0.187	41%	0.282	80%	0845-0925	0.195	39%	0.237	67%
Qualicum	1125-1145	0.117	24%	0.265	66%	0925-0945	0.239	53%	0.254	65%
Comox	1145-1205	0.19	28%	0.167	29%	0945-1005	0.267	67%	0.143	40%
Campbell Rive	1205-1240	0.301	85%	0.226	60%	1005-1040	0.276	87%	0.389	96%
Stuart Island	1240-1300					1040-1100			0.316	50%
Sechelt	1300-1450	0.28	78%	0.250	58%	1100-1250	0.414	100%	0.181	35%
Mean		0.300	64%	0.294	68%		0.329	72%	0.282	52%
Weekends										
Vancouver	0700-0740	0.404	71%	0.365	52%	0900-0940	0.596	97%	0.383	69%
Victoria	0740-0840	0.405	97%	0.465	89%	0940-1040	0.562	100%	0.520	100%
Saanich	0840-0845			0.227	45%	1040-1045	0.197	80%	0.158	33%
Nanaimo	0845-0925	0.368	100%	0.286	94%	1045-1125	0.309	92%	0.305	84%
Qualicum	0925-0945	0.415	100%	0.391	100%	1125-1145	0.151	39%	0.194	42%
Comox	0945-1005	0.222	50%	0.220	33%	1145-1205	0.333	50%	0.400	86%
Campbell Rive	1005-1040	0.379	100%	0.404	100%	1205-1240	0.309	89%	0.367	103%
Stuart Island	1040-1100			0.400	67%	1240-1300			0.000	0%
Sechelt	1100-1250	0.294	91%	0.394	94%	1300-1450	0.266	72%	0.415	100%
Mean		0.355	87%	0.350	75%		0.340	77%	0.305	69%

Option3. Vancouver to Victoria to Nanaimo to Sechelt,to Stuart Island and to Qualicum, July and August 1998.

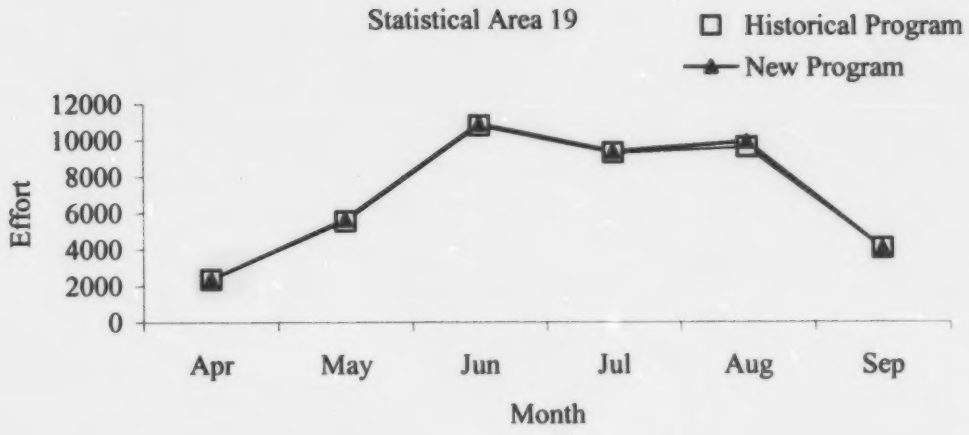
Weekdays		Jul-98	% of Max	Jul-99	% of Max		Aug-98	% of Max	Aug-99	% of Max
Vancouver	0900-0940	0.487	92%	0.500	86%	1000-1040	0.635	106%	0.576	100%
Victoria	0940-1040	0.538	100%	0.367	100%	1040-1140	0.549	97%	0.420	86%
Saanich	1040-1045					1140-1145				
Nanaimo	1045-1125	0.187	41%	0.282	80%	1145-1225	0.162	33%	0.262	74%
Sechelt	1125-1315	0.24	67%	0.286	66%	1225-1415	0.276	67%	0.186	35%
Stuart Island	1315-1335					1415-1435			0.474	75%
Campbell Rive	1335-1410	0.246	69%	0.168	45%	1435-1510	0.268	84%	0.276	68%
Comox	1410-1430	0.286	43%	0.310	54%	1510-1530	0.200	50%	0.286	80%
Qualicum	1430-1450	0.064	13%	0.074	18%	1530-1550	0.059	13%	0.083	21%
Mean		0.293	61%	0.284	64%		0.307	64%	0.320	68%
Weekends										
Vancouver	0900-0940	0.519	92%	0.624	89%	0900-0940	0.596	97%	0.383	69%
Victoria	0940-1040	0.428	103%	0.524	100%	0940-1040	0.562	100%	0.520	100%
Saanich	1040-1045			0.318	64%	1040-1045	0.197	80%	0.158	33%
Nanaimo	1045-1125	0.345	94%	0.252	83%	1045-1125	0.309	92%	0.305	84%
Sechelt	1125-1315	0.294	91%	0.394	94%	1125-1315	0.367	100%	0.270	65%
Stuart Island	1315-1335			0.100	17%	1315-1335			0.063	13%
Campbell Rive	1335-1410	0.304	80%	0.329	81%	1335-1410	0.334	96%	0.354	99%
Comox	1410-1430	0.444	100%	0.660	100%	1410-1430	0.400	60%	0.267	57%
Qualicum	1430-1450	0.049	12%	0.135	35%	1430-1450	0.125	33%	0.085	18%
Mean		0.340	82%	0.371	74%		0.361	82%	0.267	60%

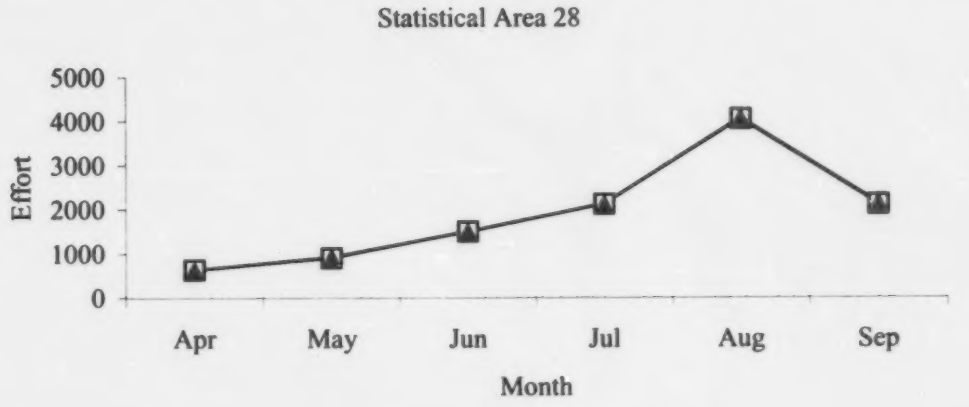


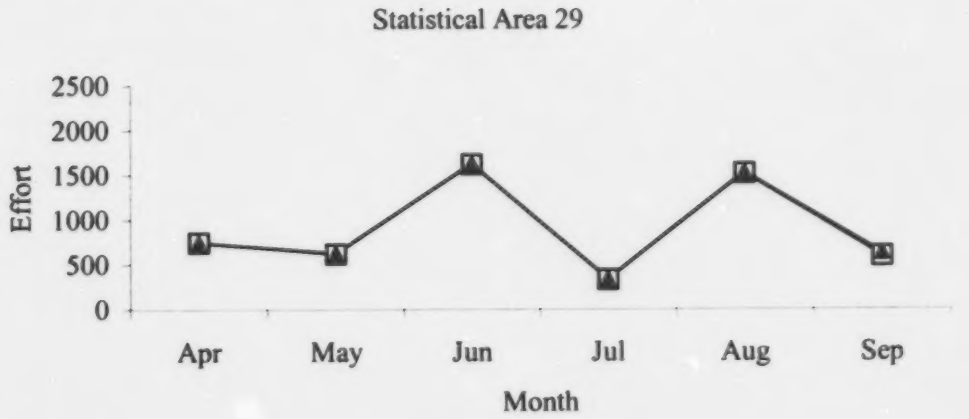
Appendix Figure F1. Comparison of historical method of estimating sport fishing effort with proposed new method using daily survey timing for 1998.



Appendix Figure F2. Comparison of historical method of estimating sport fishing effort with proposed new method using daily survey timing for 1998.







Appendix Figure F3. Comparison of historical method of estimating sport fishing effort with proposed new method using daily survey timing for 1998.

Appendix Table G1. Comparison of the 1998 catch estimates, by statistical area, for the old and new analysis methods.

			13	14	15	16	17	18	19	28	29	Total
Fishing Effort		Old Method	25,706	26,380	3,862	16,952	15,554	10,097	45,469	11,323	5,419	160,762
		New Method	25,639	26,294	4,627	17,512	15,636	10,101	46,011	11,353	5,471	162,643
Kept Salmon												
	Coho	Old Method	14	75	20	112	0	0	64	229	98	611
		New Method	0	85	27	119	0	0	65	1,696	114	2,107
	Chinook	Old Method	3,903	4,475	644	1,283	1,770	1,122	6,345	544	512	20,597
		New Method	4,019	5,113	1,079	996	1,385	1,004	6,526	501	526	21,151
	Pink	Old Method	3,673	17	11	0	0	0	1,946	2	2	5,650
		New Method	3,141	16	0	0	0	0	1,934	17	11	5,119
	Sockeye	Old Method	1,334	17	0	0	0	0	2,296	382	10	4,039
		New Method	1,428	19	0	0	0	0	1,940	0	203	3,590
	Chum	Old Method	3,035	11	23	0	0	0	149	90	8	3,315
		New Method	3,046	18	0	0	0	0	201	63	18	3,346
	All Salmon	Old Method	11,959	4,595	697	1,395	1,770	1,122	10,829	1,278	657	34,301
		New Method	11,634	5,251	1,106	1,115	1,385	1,004	10,690	2,296	1,425	35,907
Released Salmon												
	Coho	Old Method	4,767	2,422	271	454	998	176	9,887	1,054	169	20,199
		New Method	4,477	2,526	288	173	929	194	10,215	2,282	341	21,426
	Chinook	Old Method	4,854	10,184	923	1,860	3,877	2,005	9,725	1,956	816	36,199
		New Method	5,009	12,394	732	953	4,457	2,177	10,083	1,458	1,770	39,033
	Total Release	Old Method	13,581	15,139	1,430	2,352	5,830	2,455	25,371	5,533	1,064	72,755
		New Method	13,428	17,842	1,026	1,153	6,015	2,635	26,339	4,131	3,010	75,578
Kept Non-Salmon												
	Halibut	Old Method	67	36	19	0	0	0	2,157	0	0	2,280
		New Method	143	0	0	0	0	31	1,896	0	0	2,070
	Lingcod	Old Method	499	197	6	480	490	248	750	973	46	3,690
		New Method	507	278	63	480	586	146	671	92	40	2,863
	Other	Old Method	3,101	1,247	188	6,661	1,680	464	25,895	894	865	40,995
		New Method	3,432	1,121	66	8,889	2,425	1,054	23,506	876	854	42,223

Appendix Table G2. Comparison of the 1998 precision estimates[1], by statistical area, for old and new analysis methods.

			13	14	15	16	17	18	19	28	29	Total
Fishing Effort		Old Method	1,501	2,305	591	1,647	1,171	1,004	1,771	855	834	4,192
		New Method	1,360	1,656	378	796	1,097	810	1,594	618	812	3,288
Kept Salmon												
	Coho	Old Method	14	46	19	68	0	0	45	137	25	170
		New Method	0	55	23	79	0	0	46	232	34	259
	Chinook	Old Method	315	777	165	255	197	301	631	138	224	1,180
		New Method	391	657	270	173	177	218	640	81	153	1,098
	Pink	Old Method	436	13	9	0	0	0	440	1	2	620
		New Method	508	13	0	0	0	0	443	17	14	675
	Sockeye	Old Method	198	16	0	0	0	0	611	292	4	706
		New Method	352	20	0	0	0	0	584	0	151	698
	Chum	Old Method	696	9	26	0	0	0	64	79	5	704
		New Method	868	8	0	0	0	0	79	29	18	872
	All Salmon	Old Method	1,045	785	170	266	197	301	1,103	361	227	1,826
		New Method	1,233	663	271	190	177	218	1,092	259	468	1,905
Released Salmon												
	Coho	Old Method	547	723	148	163	232	111	1,193	433	46	1,597
		New Method	651	704	105	44	263	98	1,274	564	150	1,725
	Chinook	Old Method	438	1,614	394	504	563	446	1,225	445	280	2,344
		New Method	599	1,634	222	182	714	411	1,230	212	604	2,390
	Total Release	Old Method	1,161	2,414	541	617	800	507	2,263	1,832	290	4,160
		New Method	1,264	2,137	308	203	883	457	2,309	652	975	3,741
Kept Non-Salmon												
	Halibut	Old Method	33	27	17	0	0	0	448	0	0	450
		New Method	85	0	0	0	0	10	435	0	0	444
	Lingcod	Old Method	87	99	6	205	92	69	165	392	27	504
		New Method	134	90	40	192	145	44	162	47	11	341
	Other	Old Method	402	412	99	1,295	408	234	4,064	346	551	4,380
		New Method	637	300	38	1,414	603	526	3,455	196	356	3,904

[1] Precision estimates are standard deviation of the mean.

Appendix Table G3. Comparison of the 1998 coefficients of variation, by statistical area, for old and new analysis methods.

			13	14	15	16	17	18	19	28	29	Total
Fishing Effort		Old Method	6%	9%	15%	10%	8%	10%	4%	8%	15%	3%
		New Method	5%	6%	8%	5%	7%	8%	3%	5%	15%	2%
Kept Salmon												
	Coho	Old Method	103%	62%	95%	61%			71%	60%	25%	28%
		New Method		64%	85%	67%			70%	14%	30%	12%
	Chinook	Old Method	8%	17%	26%	20%	11%	27%	10%	25%	44%	6%
		New Method	10%	13%	25%	17%	13%	22%	10%	16%	29%	5%
	Pink	Old Method	12%	77%	86%				23%	79%	88%	11%
		New Method	16%	83%					23%	99%	123%	13%
	Sockeye	Old Method	15%	92%		159%			27%	76%	45%	17%
		New Method	25%	102%					30%		75%	19%
	Chum	Old Method	23%	80%	115%				43%	88%	67%	21%
		New Method	28%	48%					39%	47%	98%	26%
	All Salmon	Old Method	9%	17%	24%	19%	11%	27%	10%	28%	35%	5%
		New Method	11%	13%	25%	17%	13%	22%	10%	11%	33%	5%
Released Salmon												
	Coho	Old Method	11%	30%	55%	36%	23%	63%	12%	41%	27%	8%
		New Method	15%	28%	36%	26%	28%	51%	12%	25%	44%	8%
	Chinook	Old Method	9%	16%	43%	27%	15%	22%	13%	23%	34%	6%
		New Method	12%	13%	30%	19%	16%	19%	12%	15%	34%	6%
	Total Release	Old Method	9%	16%	38%	26%	14%	21%	9%	33%	27%	6%
		New Method	9%	12%	30%	18%	15%	17%	9%	16%	32%	5%
Kept Non-Salmon												
	Halibut	Old Method	50%	75%	90%				21%			20%
		New Method	59%					33%	23%			21%
	Lingcod	Old Method	17%	50%	90%	43%	19%	28%	22%	40%	59%	14%
		New Method	26%	32%	65%	40%	25%	30%	24%	51%	29%	12%
	Other	Old Method	13%	33%	53%	19%	24%	50%	16%	39%	64%	11%
		New Method	19%	27%	58%	16%	25%	50%	15%	22%	42%	9%

Appendix Table G4. Comparison of the 1998 catch estimates, by month, for the old and new analysis methods.

			Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Fishing Effort		Old Method	11,816	15,299	31,499	32,057	42,947	23,406	3,737	160,762
		New Method	11,707	15,432	31,645	32,022	43,075	25,026	3,736	162,643
Kept Salmon										
	Coho	Old Method	0	71	31	156	112	240	0	611
		New Method	0	126	28	305	1,179	470	0	2,107
	Chinook	Old Method	1,336	1,313	4,144	4,315	6,959	2,143	388	20,597
		New Method	1,331	1,289	3,938	4,003	7,125	3,176	288	21,151
	Pink	Old Method	0	0	0	3,241	2,365	44	0	5,650
		New Method	0	0	0	2,837	2,249	33	0	5,119
	Sockeye	Old Method	0	0	67	632	3,296	43	0	4,039
		New Method	0	0	69	645	2,826	51	0	3,590
	Chum	Old Method	0	0	18	46	98	3,085	68	3,315
		New Method	0	0	15	47	132	3,068	84	3,346
	All Salmon	Old Method	1,336	1,384	4,261	8,390	12,919	5,555	456	34,301
		New Method	1,331	1,415	4,050	7,836	14,105	6,798	372	35,907
Released Salmon										
	Coho	Old Method	189	165	3,346	4,279	7,988	3,807	423	20,199
		New Method	213	121	3,071	4,664	8,486	4,583	288	21,426
	Chinook	Old Method	1,457	1,343	5,349	6,007	14,282	7,269	492	36,199
		New Method	1,681	1,122	5,136	5,861	14,437	10,326	469	39,033
	Total Release	Old Method	1,898	1,650	9,823	13,202	30,808	14,355	1,020	72,755
		New Method	2,149	1,275	9,356	13,249	30,195	18,509	846	75,578
Kept Non-Salmon										
	Halibut	Old Method	200	121	61	794	788	237	79	2,280
		New Method	169	135	71	811	629	171	84	2,070
	Lingcod	Old Method	51	38	759	852	798	1,183	9	3,690
		New Method	53	27	874	878	569	450	11	2,863
	Other	Old Method	2,765	3,720	11,438	10,228	11,619	1,063	161	40,995
		New Method	2,797	4,637	10,872	10,419	12,491	884	124	42,223

Appendix Table G5. Comparison of the 1998 precision estimates[1], by month, for old and new analysis methods.

			Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Fishing Effort		Old Method	922	1,131	1,702	1,797	2,349	1,900	432	4,192
		New Method	778	1,022	1,513	1,471	1,611	1,423	293	3,288
Kept Salmon										
	Coho	Old Method	0	56	31	61	40	139	0	170
		New Method	0	80	27	88	204	103	0	259
	Chinook	Old Method	280	189	479	486	796	380	188	1,180
		New Method	199	207	470	486	619	511	148	1,098
	Pink	Old Method	0	0	0	553	279	22	0	620
		New Method	0	0	0	563	370	24	0	675
	Sockeye	Old Method	0	0	67	360	602	27	0	706
		New Method	0	0	68	369	588	35	0	698
	Chum	Old Method	0	0	11	46	27	701	39	704
		New Method	0	0	16	47	56	867	49	872
	All Salmon	Old Method	280	197	485	981	1,107	869	193	1,826
		New Method	199	222	475	969	1,123	1,044	155	1,905
Released Salmon										
	Coho	Old Method	55	74	683	806	985	618	269	1,597
		New Method	96	56	626	988	959	809	148	1,725
	Chinook	Old Method	340	263	862	889	1,487	1,235	200	2,344
		New Method	284	239	886	987	1,313	1,430	219	2,390
	Total Release	Old Method	368	287	1,381	1,613	2,962	1,919	343	4,160
		New Method	341	254	1,341	1,769	2,185	2,010	270	3,741
Kept Non-Salmon										
	Halibut	Old Method	55	61	33	357	244	81	42	450
		New Method	50	63	36	364	223	69	49	444
	Lingcod	Old Method	25	23	211	178	292	302	9	504
		New Method	32	35	233	179	128	105	12	341
	Other	Old Method	734	864	3,285	1,978	1,746	373	85	4,380
		New Method	636	949	2,619	1,945	1,803	186	78	3,904

1 Precision estimates are standard deviation of the mean.

Appendix Table G6. Comparison of the 1998 coefficient of variation, by month, for old and new analysis methods.

			Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Fishing Effort		Old Method	8%	7%	5%	6%	5%	8%	12%	3%
		New Method	7%	7%	5%	5%	4%	6%	8%	2%
Kept Salmon										
	Coho	Old Method		79%	99%	39%	36%	58%		28%
		New Method		64%	100%	29%	17%	22%		12%
	Chinook	Old Method	21%	14%	12%	11%	11%	18%	48%	6%
		New Method	15%	16%	12%	12%	9%	16%	51%	5%
	Pink	Old Method				17%	12%	50%		11%
		New Method				20%	16%	71%		13%
	Sockeye	Old Method			100%	57%	18%	63%		17%
		New Method			99%	57%	21%	67%		19%
	Chum	Old Method			60%	101%	28%	23%	57%	21%
		New Method			105%	101%	42%	28%	58%	26%
	All Salmon	Old Method	21%	14%	11%	12%	9%	16%	42%	5%
		New Method	15%	16%	12%	12%	8%	15%	42%	5%
Released Salmon										
	Coho	Old Method	29%	45%	20%	19%	12%	16%	64%	8%
		New Method	45%	46%	20%	21%	11%	18%	52%	8%
	Chinook	Old Method	23%	20%	16%	15%	10%	17%	41%	6%
		New Method	17%	21%	17%	17%	9%	14%	47%	6%
	Total Release	Old Method	19%	17%	14%	12%	10%	13%	34%	6%
		New Method	16%	20%	14%	13%	7%	11%	32%	5%
Kept Non-Salmon										
	Halibut	Old Method	28%	50%	53%	45%	31%	34%	53%	20%
		New Method	29%	47%	51%	45%	35%	41%	58%	21%
	Lingcod	Old Method	50%	60%	28%	21%	37%	26%	110%	14%
		New Method	59%	129%	27%	20%	23%	23%	110%	12%
	Other	Old Method	27%	23%	29%	19%	15%	35%	52%	11%
		New Method	23%	20%	24%	19%	14%	21%	63%	9%

Appendix Table H1. Comparison of the 1999 catch estimates, by statistical area, for old and new analysis methods.

			13	14	15	16	17	18	19	28	29	Total
Fishing Effort		Old Method	35,860	22,758	2,589	16,737	21,536	9,069	40,512	11,181	4,999	165,242
		New Method	36,209	23,043	2,649	17,107	21,250	9,284	41,607	11,609	5,107	167,866
Kept Salmon												
	Coho	Old Method	418	8	5	0	7	0	0	8	31	478
		New Method	521	2	25	1	7	0	124	196	11	887
	Chinook	Old Method	9,658	8,628	701	4,600	8,831	829	8,023	1,482	942	43,694
		New Method	13,023	9,473	648	3,194	7,465	816	9,594	1,620	1,237	47,070
	Pink	Old Method	23,935	568	104	1	30	176	2,897	8	129	27,848
		New Method	29,970	459	0	8	23	1,172	6,327	558	150	38,668
	Sockeye	Old Method	142	4	0	0	11	2	332	0	0	492
		New Method	314	5	0	0	8	0	600	0	0	927
	Chum	Old Method	4,401	0	0	0	0	0	0	0	8	4,410
		New Method	5,412	0	0	0	0	0	0	1	25	5,437
	All Salmon	Old Method	38,554	9,208	810	4,601	8,879	1,007	11,253	1,498	1,111	76,921
		New Method	49,240	9,939	673	3,204	7,503	1,988	16,657	2,375	1,422	93,002
Released Salmon												
	Coho	Old Method	6,740	2,901	258	1,957	1,374	56	577	24	206	14,093
		New Method	10,830	2,880	327	1,038	1,192	84	926	708	241	18,226
	Chinook	Old Method	9,822	20,212	1,783	5,188	12,760	1,524	2,232	4,777	2,082	60,380
		New Method	9,715	21,113	2,029	4,768	10,835	1,300	2,883	2,640	2,297	57,580
	Total Release	Old Method	36,171	28,729	2,371	7,166	17,892	2,231	4,031	4,813	2,445	105,847
		New Method	41,314	31,625	2,364	5,955	15,420	2,219	5,232	3,860	2,926	110,916
Kept Non-Salmon												
	Halibut	Old Method	43	37	0	1	0	6	2,406	0	0	2,494
		New Method	55	27	0	0	0	11	1,161	0	0	1,254
	Lingcod	Old Method	1,454	70	25	198	540	105	1,178	150	47	3,766
		New Method	1,386	169	200	279	781	104	888	98	27	3,933
	Other	Old Method	2,633	655	121	5,653	236	243	4,029	31	382	13,984
		New Method	2,107	538	10	7,243	128	426	3,448	232	684	14,816

Appendix Table H2. Comparison of the 1999 precision estimates[1], by statistical area, for old and new analysis methods.

			13	14	15	16	17	18	19	28	29	Total
Fishing Effort		Old Method	1,984	1,925	424	1,141	1,512	872	3,533	1,151	617	5,134
		New Method	1,848	1,781	400	926	1,407	857	3,244	874	576	4,684
Kept Salmon												
	Coho	Old Method	81	6	4	0	5	0	0	6	15	83
		New Method	128	2	28	2	8	0	64	84	7	169
	Chinook	Old Method	749	788	123	829	864	157	1,548	501	248	2,317
		New Method	1,130	885	104	533	978	131	1,461	250	319	2,372
	Pink	Old Method	3,112	181	49	1	13	58	578	3	49	3,171
		New Method	3,999	155	0	11	13	608	996	148	78	4,172
	Sockeye	Old Method	40	4	0	0	8	2	175	0	0	180
		New Method	140	6	0	0	7	0	187	0	0	234
	Chum	Old Method	737	0	0	0	0	0	0	1	9	737
		New Method	890	0	0	0	0	0	0	1	28	891
	All Salmon	Old Method	3,577	838	134	829	869	171	1,726	501	270	4,277
		New Method	4,623	916	116	533	979	623	1,951	319	345	5,280
Released Salmon												
	Coho	Old Method	577	495	66	726	197	30	164	9	82	1,088
		New Method	1,327	448	135	311	262	33	193	198	78	1,493
	Chinook	Old Method	738	3,510	500	720	1,066	308	1,025	2,316	691	4,664
		New Method	956	3,509	483	1,038	1,104	205	1,038	451	768	4,203
	Total Release	Old Method	2,461	4,245	595	1,059	1,668	409	1,179	2,316	710	5,980
		New Method	3,206	4,319	616	1,206	1,603	314	1,161	582	815	5,983
Kept Non-Salmon												
	Halibut	Old Method	23	31	0	1	0	7	896	0	0	897
		New Method	40	27	0	0	0	3	430	0	0	433
	Lingcod	Old Method	162	45	11	92	112	33	588	109	19	639
		New Method	237	85	258	142	167	36	411	53	18	593
	Other	Old Method	295	261	72	1,560	70	103	1,246	20	133	2,044
		New Method	311	180	5	1,779	40	129	1,021	129	256	2,106

[1] Precision estimates are standard deviation of the mean.

Appendix Table H3. Comparison of the 1999 coefficients of variation, by statistical area, for old and new analysis methods.

			13	14	15	16	17	18	19	28	29	Total
Fishing Effort		Old Method	6%	8%	16%	7%	7%	10%	9%	10%	12%	3%
		New Method	5%	8%	15%	5%	7%	9%	8%	8%	11%	3%
Kept Salmon												
	Coho	Old Method	19%	70%	80%		73%			74%	47%	17%
		New Method	25%	118%	112%	170%	108%		52%	43%	66%	19%
	Chinook	Old Method	8%	9%	18%	18%	10%	19%	19%	34%	26%	5%
		New Method	9%	9%	16%	17%	13%	16%	15%	15%	26%	5%
	Pink	Old Method	13%	32%	47%	92%	43%	33%	20%	45%	38%	11%
		New Method	13%	34%		130%	54%	52%	16%	26%	52%	11%
	Sockeye	Old Method	28%	87%			70%	80%	53%			37%
		New Method	45%	113%			85%		31%			25%
	Chum	Old Method	17%							129%	117%	17%
		New Method	16%							54%	114%	16%
	All Salmon	Old Method	9%	9%	17%	18%	10%	17%	15%	33%	24%	6%
		New Method	9%	9%	17%	17%	13%	31%	12%	13%	24%	6%
Released Salmon												
	Coho	Old Method	9%	17%	26%	37%	14%	52%	28%	39%	40%	8%
		New Method	12%	16%	41%	30%	22%	39%	21%	28%	32%	8%
	Chinook	Old Method	8%	17%	28%	14%	8%	20%	46%	48%	33%	8%
		New Method	10%	17%	24%	22%	10%	16%	36%	17%	33%	7%
	Total Release	Old Method	7%	15%	25%	15%	9%	18%	29%	48%	29%	6%
		New Method	8%	14%	26%	20%	10%	14%	22%	15%	28%	5%
Kept Non-Salmon												
	Halibut	Old Method	53%	82%		161%		112%	37%			36%
		New Method	73%	98%				29%	37%			35%
	Lingcod	Old Method	11%	65%	43%	46%	21%	32%	50%	73%	39%	17%
		New Method	17%	50%	129%	51%	21%	34%	46%	55%	68%	15%
	Other	Old Method	11%	40%	60%	28%	30%	42%	31%	63%	35%	15%
		New Method	15%	33%	49%	25%	31%	30%	30%	56%	37%	14%

Appendix Table H4. Comparison of the 1999 catch estimates, by month, for old and new analysis methods.

			Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Fishing Effort		Old Method	9,611	9,518	35,840	40,168	41,078	26,060	2,966	165,242
		New Method	9,518	9,930	35,825	42,465	41,130	26,029	2,969	167,866
Kept Salmon										
	Coho	Old Method	0	0	13	11	18	273	163	478
		New Method	0	0	7	100	206	359	216	887
	Chinook	Old Method	1,813	2,569	13,092	11,186	11,152	3,852	29	43,694
		New Method	2,057	2,096	12,548	14,691	10,448	5,175	54	47,070
	Pink	Old Method	0	5	31	663	5,062	20,698	1,389	27,848
		New Method	0	2	38	2,227	9,824	24,895	1,682	38,668
	Sockeye	Old Method	0	0	11	317	163	0	0	492
		New Method	0	0	8	365	554	0	0	927
	Chum	Old Method	0	0	0	0	48	748	3,613	4,410
		New Method	0	0	0	0	131	1,403	3,904	5,437
	All Salmon	Old Method	1,813	2,574	13,147	12,178	16,444	25,572	5,194	76,921
		New Method	2,057	2,099	12,601	17,383	21,175	31,832	5,855	93,002
Released Salmon										
	Coho	Old Method	68	105	804	2,243	5,608	4,287	978	14,093
		New Method	57	105	687	2,831	6,085	7,341	1,121	18,226
	Chinook	Old Method	3,487	3,026	9,035	10,948	26,073	7,411	401	60,380
		New Method	3,368	1,763	8,436	10,523	22,443	10,647	400	57,580
	Total Release	Old Method	3,771	3,137	10,368	17,719	44,206	22,237	4,408	105,847
		New Method	3,915	1,877	9,459	18,598	43,654	28,820	4,594	110,916
Kept Non-Salmon										
	Halibut	Old Method	20	974	464	535	148	353	0	2,494
		New Method	32	430	168	330	98	196	0	1,254
	Lingcod	Old Method	10	52	658	1,104	1,059	883	0	3,766
		New Method	15	233	644	1,002	1,061	978	0	3,933
	Other	Old Method	786	694	1,493	3,057	2,900	4,909	144	13,984
		New Method	478	876	1,909	3,087	2,750	5,641	76	14,816

Appendix Table H5. Comparison of the 1999 precision estimates[1], by month, for old and new analysis methods.

			Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Fishing Effort		Old Method	854	1,180	3,394	1,832	2,283	1,965	538	5,134
		New Method	768	1,058	3,065	1,764	2,051	1,807	504	4,684
Kept Salmon										
	Coho	Old Method	0	0	10	6	8	66	49	83
		New Method	0	0	7	58	79	114	76	169
	Chinook	Old Method	340	629	1,716	867	915	566	18	2,317
		New Method	419	288	1,727	1,142	761	707	37	2,372
	Pink	Old Method	0	5	13	173	588	3,095	325	3,171
		New Method	0	3	25	475	1,329	3,907	385	4,172
	Sockeye	Old Method	0	0	8	173	48	0	0	180
		New Method	0	0	7	157	173	0	0	234
	Chum	Old Method	0	0	0	0	18	139	724	737
		New Method	0	0	0	0	73	409	788	891
	All Salmon	Old Method	340	630	1,719	921	1,223	3,385	1,012	4,277
		New Method	419	288	1,728	1,330	1,716	4,327	1,096	5,280
Released Salmon										
	Coho	Old Method	49	36	148	265	832	592	213	1,088
		New Method	59	48	207	448	617	1,232	284	1,493
	Chinook	Old Method	700	1,126	1,246	985	4,047	1,029	173	4,664
		New Method	760	360	1,346	944	3,499	1,407	181	4,203
	Total Release	Old Method	735	1,131	1,371	1,469	4,710	2,629	897	5,980
		New Method	863	371	1,408	1,564	4,458	3,118	942	5,983
Kept Non-Salmon										
	Halibut	Old Method	22	677	458	326	54	164	0	897
		New Method	25	354	139	180	39	92	0	433
	Lingcod	Old Method	9	41	127	213	207	549	0	639
		New Method	13	265	165	207	195	417	0	593
	Other	Old Method	252	160	411	636	504	1,805	57	2,044
		New Method	193	307	519	450	589	1,867	47	2,106

[1] Precision estimates are standard deviation of the mean.

Appendix Table H6. Comparison of the 1999 coefficient of variation, by month, for old and new analysis methods.

			Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Fishing Effort		Old Method	9%	12%	9%	5%	6%	8%	18%	3%
		New Method	8%	11%	9%	4%	5%	7%	17%	3%
Kept Salmon										
	Coho	Old Method			76%	56%	44%	24%	30%	17%
		New Method			106%	58%	38%	32%	35%	19%
	Chinook	Old Method	19%	24%	13%	8%	8%	15%	61%	5%
		New Method	20%	14%	14%	8%	7%	14%	69%	5%
	Pink	Old Method		114%	43%	26%	12%	15%	23%	11%
		New Method		139%	65%	21%	14%	16%	23%	11%
	Sockeye	Old Method			70%	55%	29%			37%
		New Method			85%	43%	31%			25%
	Chum	Old Method					38%	19%	20%	17%
		New Method					56%	29%	20%	16%
	All Salmon	Old Method	19%	24%	13%	8%	7%	13%	19%	6%
		New Method	20%	14%	14%	8%	8%	14%	19%	6%
Released Salmon										
	Coho	Old Method	71%	34%	18%	12%	15%	14%	22%	8%
		New Method	103%	46%	30%	16%	10%	17%	25%	8%
	Chinook	Old Method	20%	37%	14%	9%	16%	14%	43%	8%
		New Method	23%	20%	16%	9%	16%	13%	45%	7%
	Total Release	Old Method	19%	36%	13%	8%	11%	12%	20%	6%
		New Method	22%	20%	15%	8%	10%	11%	21%	5%
Kept Non-Salmon										
	Halibut	Old Method	107%	70%	99%	61%	36%	46%		36%
		New Method	78%	82%	83%	54%	39%	47%		35%
	Lingcod	Old Method	87%	78%	19%	19%	20%	62%		17%
		New Method	85%	114%	26%	21%	18%	43%		15%
	Other	Old Method	32%	23%	28%	21%	17%	37%	39%	15%
		New Method	40%	35%	27%	15%	21%	33%	62%	14%